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PROCEEDINGS

OF

The American Association

FOR THE

ADVANCEMENT OF SCIENCE,

FIFTY-SECOND MEETING

HELD AT

WASHINGTON, D. C.

DECEMBER, 1902–JANUARY, 1903.

PUBLISHED BY THE PERMANENT SECRETARY

1903

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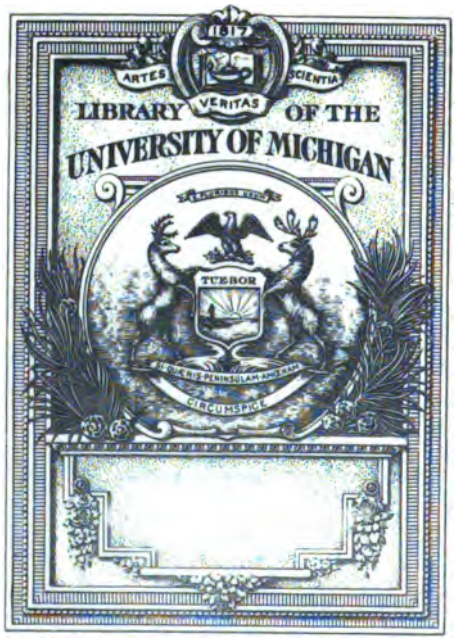

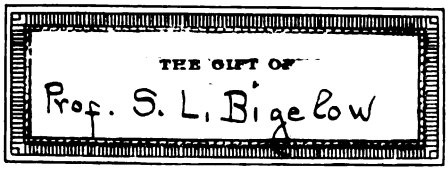

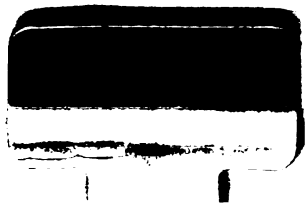

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EDITED BY

L. O. HOWARD,

Permanent Secretary.

WASHINGTON, D. C.
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Meetings and Officers of the Association of American Geologists and Naturalists.

Meeting.	Date.	Place.	Chairman.	Secretary.	Assistant Secretary.	Treasurer.
1st	April 2, 1840,	Philadelphia,	Edw. Hitchcock,*	L. C. Beck,*		
2d	April 5, 1841,	Philadelphia,	Benj. Silliman,*	L. C. Beck,*	B. Silliman, Jr.,* C. B. Trego,*	
3d	April 25, 1842,	Boston,	S. G. Morton,*	C. T. Jackson,*	J. D. Whitney,* M. B. Williams,*	
4th	April 26, 1843,	Albany,	Henry D. Rogers,*	B. Silliman, Jr.,*		John Locke.*
5th	May 8, 1844,	Washington,	John Locke,*	B. Silliman, Jr.,* O. P. Hubbard,		Douglas Houghton.*
6th	April 30, 1845,	New Haven,	Wm. B. Rogers,*	B. Silliman, Jr.,* J. Law. Smith,*		Douglas Houghton.*
7th	Sept. 2, 1846,	New York,	C. T. Jackson,*	B. Silliman, Jr.,*		E. C. Herrick.*
8th	Sept. 20, 1847,	Boston,	Wm. B. Rogers,*†	Jeffries Wyman,*		B. Silliman, Jr.*

* Deceased.

† Professor Rogers, as chairman of this last meeting, called the first meeting of the new Association to order and presided until it was fully organized by the adoption of a constitution. As he was thus the first presiding officer of the new Association, it was directed at the Hartford meeting that his name be placed at the head of the Past Presidents of the American Association for the Advancement of Science.

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Meetings	Place	Date	Members in attendance	Number of members
1	Philadelphia	Sept. 20, 1848	?	461
2	Cambridge	Aug. 14, 1849	?	540
3	Charleston	Mar. 12, 1850	?	622
4	New Haven	Aug. 19, 1850	?	704
5	Cincinnati	May 5, 1851	87	800
6	Albany	Aug. 19, 1851	194	769
7	Cleveland	July 28, 1853	?	940
8	Washington	April 26, 1854	168	1004
9	Providence	Aug. 15, 1855	166	605
10	2d Albany	Aug. 20, 1856	381	722
11	Montreal	Aug. 12, 1857	351	946
12	Baltimore	April 28, 1858	190	962
13	Springfield	Aug. 3, 1859	190	862
14	Newport	Aug. 1, 1860	135	644
15	Buffalo	Aug. 15, 1866	79	637
16	Burlington	Aug. 21, 1867	73	415
17	Chicago	Aug. 5, 1868	259	686
18	Salem	Aug. 18, 1869	244	511
19	Troy	Aug. 17, 1870	188	536
20	Indianapolis	Aug. 16, 1871	196	668
21	Dubuque	Aug. 15, 1872	164	610
22	Portland	Aug. 20, 1873	195	670
23	Hartford	Aug. 12, 1874	224	722
24	Detroit	Aug. 11, 1875	165	807
25	2d Buffalo	Aug. 23, 1876	215	867
26	Nashville	Aug. 29, 1877	173	953
27	St. Louis	Aug. 21, 1878	134	962
28	Saratoga	Aug. 27, 1879	256	1030
29	Boston	Aug. 25, 1880	997	1555
30	2d Cincinnati	Aug. 17, 1881	500	1699
31	2d Montreal	Aug. 23, 1882	937	1922
32	Minneapolis	Aug. 15, 1883	328	2033
33	2d Philadelphia	Sept. 3, 1884	1261*	1981
34	Ann Arbor	Aug. 26, 1885	364	1956
35	3d Buffalo	Aug. 18, 1886	445	1886
36	New York	Aug. 10, 1887	729	1956
37	2d Cleveland	Aug. 14, 1888	342	1964
38	Toronto	Aug. 26, 1889	424	1952
39	2d Indianapolis	Aug. 19, 1890	364	1944
40	2d Washington	Aug. 19, 1891	653†	2054
41	Rochester	Aug. 17, 1892	456	2037
42	Madison	Aug. 17, 1893	290	1939
43	Brooklyn	Aug. 15, 1894	488	1802
44	2d Springfield	Aug. 28, 1895	368	1913
45	4th Buffalo	Aug. 24, 1896	333	1890
46	2d Detroit	Aug. 9, 1897	283‡	1782
47	2d Boston	Aug. 22, 1898	903	1729
48	Columbus	Aug. 21, 1899	353	1721
49	2d New York	June 25, 1900	434	1925
50	Denver	Aug. 24, 1901	311	2703
51	Pittsburg	June 28 to July 3, 1902.	435	3473
52	3d Washington	Dec. 27, 1902, to Jan. 2, 1903.	975	3596

* Including 303 Members of the British Association and 9 other foreign guests.

† Including 24 Foreign Honorary Members for the meeting.

‡ Including 15 Foreign Honorary Members and Associates for the meeting.

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Officers of the Meetings of the Association.

[The number before the name is that of the meeting; the year of the meeting follows the name; the asterisk after a name indicates that the member is deceased.]

PRESIDENTS.

1. { Wm. B. Rogers,* 1848. / W. C. Redfield,* 1848.
2. Joseph Henry.* 1849.
3. { A. D. Bache,* March meeting, 1850, in the absence of
4. { Joseph Henry.* August meeting, 1850.
5. { May meeting, 1851.
6. Louis Agassiz,* August meeting, 1851. (No meeting in 1852.)
7. Benjamin Pierce,* 1853.
8. James D. Dana,* 1854.
9. John Torrey,* 1855.
10. James Hall,* 1856.
11. { Alexis Caswell,* 1857, in place of J. W. Bailey,*
12. { deceased. 1858, in the absence of Jeffries Wyman.*
13. Stephen Alexander,* 1859.
14. Isaac Lea,* 1860. (No meetings for 1861–65.)
15. F. A. P. Barnard,* 1866.
16. J. S. Newberry,* 1867.
17. B. A. Gould,* 1868.
18. J. W. Foster,* 1869.
19. T. Sterry Hunt,* 1870, in the absence of Wm. Chauvenet.*
20. Asa Gray,* 1871.
21. J. Lawrence Smith,* 1872.
22. Joseph Lovering,* 1873.
23. J. L. LeConte,* 1874.
24. J. E. Hilgard,* 1875.
25. William B. Rogers,* 1876.
26. Simon Newcomb, 1877.
27. O. C. Marsh,* 1878.
28. G. F. Barker, 1879.
29. Lewis H. Morgan,* 1880.
30. G. J. Brush, 1881.
31. J. W. Dawson, 1882.
32. C. A. Young, 1883.
33. J. P. Lesley, 1884.
34. H. A. Newton,* 1885.
35. Edward S. Morse, 1886.
36. S. P. Langley, 1887.
37. J. W. Powell,* 1888.
38. T. C. Mendenhall, 1889.
39. G. Lincoln Goodale, 1890.
40. Albert B. Prescott, 1891.
41. Joseph LeConte,* 1892.
42. William Harkness,* 1893.
43. Daniel G. Brinton,* 1894.
44. E. W. Morley, 1895.
45. { Edward D. Cope,* 1896. Theodore Gill, as senior vice-president acted after the death of Prof. Cope.
46. { Wolcott Gibbs,* 1897, absent. W J McGee, Acting President.
47. F. W. Putnam, 1898.
48. { Edward Orton,* 1899. Grove K. Gilbert, elected by the General Committee December, 1899, to fill the vacancy caused by the death of Prof. Orton.
49. R. S. Woodward, 1900.
50. C. S. Minot, 1901.
51. Asaph Hall, 1902.
52. Ira Remsen, 1903.
53. Carroll D. Wright, 1904.

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VICE-PRESIDENTS.

There were no Vice-Presidents until the 11th meeting when there was a single Vice-President for each meeting. At the 24th meeting, the Association met in Sections A and B, each presided over by a Vice-President. At the 31st meeting nine sections were organized, each with a Vice-President as its presiding officer. In 1886 Section G (Microscopy) was given up. In 1892, Section F was divided into F, Zoology; G, Botany.

1857–1874.

11. ALEXIS CASWELL,* 1857, acted as President.
12. JOHN E. HOLBROOK,* 1858, not present.
13. EDWARD HITCHCOCK,* 1859.
14. B. A. GOULD,* 1860.
15. B. A. GOULD,* 1866, in the absence of R. W. GIBBES.
16. WOLCOTT GIBBS,* 1867.
17. CHAS. WHITTLESEY,* 1868.
18. OGDEN N. ROOD, 1869.
19. T. STERRY HUNT,* 1870, acted as President.
20. G. F. BARKER, 1871.
21. ALEX. WINCHELL,* 1872,
22. A. H. WORTHEN,* 1873. not present.
23. C. S. LYMAN,* 1874.

1875–1881.

Section A.—Mathematics, Physics, and Chemistry.

24. H. A. NEWTON,* 1875.
25. C. A. YOUNG, 1876.
26. R. H. THURSTON, 1877, in the absence of E. C. PICKERING.
27. R. H. THURSTON, 1878.
28. S. P. LANGLEY, 1879.
29. ASAPH HALL, 1880.
30. WM. HARKNESS,* 1881, in the absence of A. M. MAYER.*

Section B.—Natural History.

24. J. W. DAWSON, 1875.
25. EDWARD S. MORSE, 1876.
26. O. C. MARSH,* 1877.
27. AUG. R. GROTE, 1878.
28. J. W. POWELL,* 1879.
29. ALEX. AGASSIZ, 1880.
30. EDWARD T. COX, 1881, in the absence of GEORGE ENGELMANN.*

CHAIRMEN OF SUBSECTIONS, 1875–1881.

Subsection of Chemistry.

24. S. W. JOHNSON, 1875.
25. G. F. BARKER, 1876.
26. N. T. LUPTON,* 1877.
27. F. W. CLARKE, 1878.
28. F. W. CLARKE, 1879, in the absence of IRA REMSEN.
29. J. M. ORDWAY, 1880.
30. G. C. CALDWELL, 1881, in the absence of W. R. NICHOLS.*

Subsection of Microscopy.

25. R. H. WARD, 1876.
26. R. H. WARD, 1877.
27. R. H. WARD, 1878, in the absence of G. S. BLACKIE.*
28. E. W. MORLEY, 1879.
29. S. A. LATTIMORE, 1880.
30. A. B. HERVEY, 1881.

Subsection of Anthropology.

24. LEWIS H. MORGAN,* 1875.
25. LEWIS H. MORGAN,* 1876.
26. DANIEL WILSON,* 1877, not present.
27. United with Section B.
28. DANIEL WILSON,* 1879.
29. J. W. POWELL,* 1880.
30. GARRICK MALLERY,* 1881.

Subsection of Entomology.

30. J. G. MORRIS,* 1881.

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VICE-PRESIDENTS OF SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. W. A. ROGERS,* 1882, in the absence of WM. HARKNESS.*
32. W. A. ROGERS,* 1883.
33. H. T. EDDY, 1884.
34. WM. HARKNESS,* 1885, in the absence of J. M. VAN VLECK.
35. J. W. GIBBS,* 1886.
36. J. R. EASTMAN, 1887, in place of W. FERREL,* res'd.
37. ORMOND STONE, 1888.
38. R. S. WOODWARD, 1889.
39. S. C. CHANDLER, 1890.
40. E. W. HYDE, 1891.
41. J. R. EASTMAN, 1892.
42. C. L. DOOLITTLE, 1893.
43. { G. C. COMSTOCK, 1894. / EDGAR FRISBY, 1894.
44. EDGAR FRISBY, 1895, in place of E. H. HOLDEN, resigned.
45. ALEX. MACFARLANE, 1896, in place of WM. E. STORY, resigned.
46. W. W. BEMAN, 1897.
47. E. E. BARNARD, 1898.
48. ALEX. MACFARLANE, 1899.
49. ASAPH HALL, JR., 1900.
50. JAMES MACMAHON, 1901.
51. G. W. HOUGH, 1902.
52. GEORGE BRUCE HALSTED, 1903.
53. O. H. TITTMANN, 1904.

Section B.—Physics.

31. T. C. MENDENHALL, 1882.
32. H. A. ROWLAND,* 1883.
33. J. TROWBRIDGE, 1884.
34. S. P. LANGLEY, 1885, in place of C. F. BRACKETT, res'd.
35. C. F. BRACKETT, 1886.
36. W. A. ANTHONY, 1887.
37. A. A. MICHELSON, 1888.
38. H. S. CARHART, 1889.
39. CLEVELAND ABBE, 1890.
40. F. E. NIPHER, 1891.
41. B. F. THOMAS, 1892.
42. E. L. NICHOLS, 1893.
43. WM. A. ROGERS, 1894.
44. W. LECONTE STEVENS, 1895.
45. CARL LEO MEES, 1896.
46. CARL BARUS, 1897.
47. F. P. WHITMAN, 1898.
48. ELIHU THOMSON, 1899.
49. ERNEST MERRITT, 1900.
50. D. B. BRACE, 1901.
51. W. S. FRANKLIN, 1902.
52. ERNEST F. NICHOLS, 1903.
53. E. H. HALL, 1904.

Section C.—Chemistry.

31. H. C. BOLTON, 1882.
32. E. W. MORLEY, 1883.
33. J. W. LANGLEY, 1884.
34. N. T. LUPTON,* 1885, in the absence of W. R. NICHOLS.
35. H. W. WILEY, 1886.
36. A. B. PRESCOTT, 1887.
37. C. E. MUNROE, 1888.
38. W. L. DUDLEY, 1889.
39. R. B. WARDER, 1890.
40. R. C. KEDZIE, 1891.
41. ALFRED SPRINGER, 1892.
42. EDWARD HART, 1893.
43. T. H. NORTON, 1894.
44. WM. MCMURTRIE, 1895.
45. W. A. NOYES, 1896.
46. W. P. MASON, 1897.
47. EDGAR F. SMITH, 1898.
48. F. P. VENABLE, 1899.
49. JAS. LEWIS HOWE, 1900.
50. JOHN H. LONG, 1901.
51. H. A. WEBER, 1902.
52. CHARLES BASKERVILLE, 1903.
53. W. D. BANCROFT, 1904.

Section D.—Mechanical Science and Engineering.

31. W. P. TROWBRIDGE,* 1882.

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VICE-PRESIDENTS OF SECTIONS, CONTINUED.

32. DEVOLSON WOOD, 1883, absent, but place was not filled.
33. R. H. THURSTON, 1884.
34. J. BURKITT WEBB, 1885.
35. O. CHANUTE, 1886.
36. E. B. COXE, 1887.
37. C. J. H. WOODBURY, 1888.
38. JAMES E. DENTON, 1889.
39. JAMES E. DENTON, 1890, in place of A. BEARDSLEY, absent.

Section D—Mechanical Science and Engineering, continued.

40. THOMAS GRAY, 1891.
41. J. B. JOHNSON, 1892.
42. S. W. ROBINSON, 1893.
43. MANSFIELD MERRIMAN, 1894.
44. WILLIAM KENT, 1895.
45. FRANK O. MARVIN, 1896.
46. JOHN GALBRAITH, 1897.
47. JOHN GALBRAITH, 1898, in the absence of M. E. COOLEY.
48. STORM BULL, 1899.
49. JOHN A. BRASHEAR, 1900.
50. H. S. JACOBY, 1901.
51. J. J. FLATHER, 1902.
52. CLARENCE A. WALDO, 1903.
53. C. M. WOODWARD, 1904.

Section E.—Geology and Geography.

31. E. T. COX, 1882.
32. C. H. HITCHCOCK, 1883.
33. N. H. WINCHELL, 1884.
34. EDWARD ORTON,* 1885.
35. T. C. CHAMBERLIN, 1886.
36. G. K. GILBERT, 1887.
37. GEORGE H. COOK,* 1888.
38. CHARLES A. WHITE, 1889.
39. JOHN C. BRANNER, 1890.
40. J. J. STEVENSON, 1891.
41. H. S. WILLIAMS, 1892.
42. CHARLES D. WALCOTT, 1893.
43. SAMUEL CALVIN, 1894.
44. JED. HOTCHKISS, 1895.
45. B. K. EMERSON, 1896.
46. { I. C. WHITE, 1897. E. W. CLAYPOLE,* 1897.
47. H. L. FAIRCHILD, 1898.
48. J. F. WHITEAVES, 1899.
49. J. F. KEMP, 1900.
50. C. R. VAN HISE, 1901.
51. JOSEPH A. HOLMES, 1902, in the absence of O. A. DERBY.
52. WM. M. DAVIS, 1903.
53. I. C. RUSSELL, 1904.

Section F.—Biology, 1882–1892.

31. W. H. DALL, 1882.
32. W. J. BEAL, 1883.
33. E. D. COPE,* 1884.
34. T. J. BURRILL, 1885, in the absence of B. G. WILDER.
35. H. P. BOWDITCH, 1886.
36. W. G. FARLOW, 1887.
37. C. V. RILEY,* 1888.
38. GEORGE L. GOODALE, 1889.
39. C. S. MINOT, 1890.
40. J. M. COULTER, 1891.
41. S. H. GAGE, 1892.

Section F.—Zoology.

42. HENRY F. OSBORN, 1893.
43. J. A. LINTNER,* 1894, in place of S. H. SCUDDER, resigned.
44. L. O. HOWARD, 1895, in place of D. S. JORDAN, res'd.
45. THEO. GILL, 1896.
46. L. O. HOWARD, 1897, in place of G. BROWN GOODE,* deceased.
47. A. S. PACKARD, 1898.
48. S. H. GAGE, 1899.
49. C. B. DAVENPORT, 1900.
50. D. S. JORDAN, 1901.
51. E. L. MARK, 1902, in the absence of C. C. NUTTING.
52. C. W. HARGITT, 1903.
53. E. L. MARK, 1904.

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VICE-PRESIDENTS OF SECTIONS, CONTINUED.

Section G. Microscopy, 1882–85.
31. A. H. TUTTLE, 1882.
32. J. D. COX, 1883.
33. T. G. WORMLEY,* 1884.
34. S. H. GAGE, 1885.
(Section united with F in 1886)

Section G.—Botany.
42. CHARLES E. BESSEY, 1893.
43. { L. M. UNDERWOOD, 1894. / C. E. BESSEY, 1894.
44. J. C. ARTHUR, 1895.
45. N. L. BRITTON, 1896.
46. G. F. ATKINSON, 1897.
47. W. G. FARLOW, 1898.
48. C. R. BARNES, 1899.
49. W. TRELEASE, 1900.
50. B. T. GALLOWAY, 1901.
51. C. E. BESSEY, 1902, in the absence of D. H. CAMPBELL.
52. F. V. COVILLE, 1903.
53. T. H. MACBRIDE, 1904.

Section H.—Anthropology.
31. ALEX. WINCHELL,* 1882.
32. OTIS T. MASON, 1883.
33. EDWARD S. MORSE, 1884.
34. J. OWEN DORSEY,* 1885, in the absence of W. H. DALL.
35. HORATIO HALE,* 1886.
36. D. G. BRINTON,* 1887.
37. CHARLES C. ABBOTT, 1888.
38. GARRICK MALLERY,* 1889.
39. FRANK BAKER, 1890.
40. JOSEPH JASTROW, 1891.
41. W. H. HOLMES, 1892.
42. J. OWEN DORSEY,* 1893.
43. FRANZ BOAS, 1894.
44. F. H. CUSHING,* 1895.
45. ALICE C. FLETCHER, 1896.
46. W J MCGEE, 1897.
47. J. MCK. CATTELL, 1898.
48. THOMAS WILSON,* 1899.
49. A. W. BUTLER, 1900.
50. J. WALTER FEWKES, 1901.
51. STEWART CULIN, 1902.
52. GEO. A. DORSEY, 1903.
53. M. H. SAVILLE, 1904.

Section I.—Social and Economic Science.
31. E. B. ELLIOTT,* 1882.
32. FRANKLIN B. HOUGH,* 1883.
33. JOHN EATON,* 1884.
34. EDWARD ATKINSON, 1885.
35. JOSEPH CUMMINGS,* 1886.
36. H. E. ALVORD, 1887.
37. CHARLES W. SMILEY, 1888.
38. CHARLES S. HILL, 1889.
39. J. RICHARDS DODGE, 1890.
40. EDMUND J. JAMES, 1891.
41. L. F. WARD, 1892, in place of S. D. HORTON,* resigned.
42. WILLIAM H. BREWER, 1893.
43. HENRY FARQUHAR, 1894.
44. B. E. FERNOW, 1895.
45. W. L. LAZENBY, 1896.
46. R. T. COLBURN, 1897.
47. ARCHIBALD BLUE, 1898.
48. MARCUS BENJAMIN, 1899.
49. MARCUS BENJAMIN, 1900, in the absence of C. M. WOODWARD.
50. JOHN HYDE, 1901.
51. JOHN HYDE, 1902, in the absence of CARROLL D. WRIGHT.
52. H. T. NEWCOMB, 1903.
53. SIMEON E. BALDWIN, 1904.

Section K.—Physiology and Experimental Medicine.
51. W. H. WELCH, 1902.
52. W. H. WELCH, 1903.
53. H. P. BOWDITCH, 1904.

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SECRETARIES.

General Secretaries, 1848–

1. Walter R. Johnson,* 1848
2. E. N. Horsford,* 1849, in the absence of Jeffries Wyman.*
3. L. R. Gibbs, 1850, in the absence of E. C. Herrick.*
4. E. C. Herrick,* 1850.
5. Wm. B. Rogers,* 1851, in the absence of E. C. Herrick.
6. Wm. B. Rogers,* 1851.
7. S. St. John,* 1853, in the absence of J. D. Dana.*
8. J. Lawrence Smith,* 1854.
9. Wolcott Gibbs, 1855.
10. B. A. Gould,* 1856.
11. John L. LeConte,* 1857.
12. W. M. Gillespie,* 1858, in the absence of Wm. Chauvenet,*
13. Wm. Chauvenet,* 1859.
14. Joseph LeConte,* 1860.
15. Elias Loomis,* 1866, in the absence of W. P. Trowbridge.*
16. C. S. Lyman,* 1867.
17. Simon Newcomb, 1868, in the absence of A. P. Rockwell.
18. O. C. Marsh,* 1869.
19. F. W. Putnam, 1870, in the absence of C. F. Hartt.*
20. F. W. Putnam, 1871.
21. Edward S. Morse, 1872.
22. C. A. White, 1873.
23. A. C. Hamlin, 1874.
24. S. H. Scudder, 1875.
25. T. C. Mendenhall, 1876.
26. Aug. R. Grote, 1877.
27. H. C. Bolton, 1878.
28. H. C. Bolton, 1879, in the absence of George Little.
29. J. K. Rees, 1880.
30. C. V. Riley,* 1881.
31. William Saunders, 1882.
32. J. R. Eastman, 1883.
33. Alfred Springer, 1884.
34. C. S. Minot, 1885.
35. S. G. Williams,* 1886.
36. William H. Pettee, 1887.
37. Julius Pohlman, 1888.
38. C. Leo Mees, 1889.
39. H. C. Bolton, 1890.
40. H. W. Wiley, 1891.
41. A. W. Butler, 1892.
42. T. H. Norton, 1893.
43. H. L. Fairchild, 1894.
44. Jas. Lewis Howe, 1895.
45. Charles R. Barnes, 1896.
46. Asaph Hall, Jr., 1897.
47. J. McMahon, 1898, in place of D. S. Kellicott,* deceased.
48. F. Bedell, 1899.
49. Chas. Baskerville, 1900.
50. John M. Coulter, 1901, in the absence of William Hallock.
51. D. T. MacDougal, 1902.
52. Henry B. Ward, 1903.
53. C. W. Stiles, 1904.

Permanent Secretaries, 1851–

5–7. Spencer F. Baird,* 1851–4
8–17. Joseph Lovering,* 1854–68.
18. F. W. Putnam, 1869, in the absence of J. Lovering.*
19–21. Joseph Lovering,* 1870–73.
22–46. F. W. Putnam, 1873–98.
47–54. L. O. Howard, 1898–05.

Assistant General Secretaries, 1882–1887.

31. J. R. Eastman, 1882.
32. Alfred Springer, 1883.
33. C. S. Minot, 1884, in the absence of E. S. Holden.
34. S. G. Williams,* 1885, in the absence of C. C. Abbott.

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SECRETARIES, CONTINUED.

35. W. H. PETTEE, 1886.
36. J. C. ARTHUR, 1887.

Secretaries of the Council, 1888–

37. C. LEO MEES, 1888.
38. H. C. BOLTON, 1889.
39. H. W. WILEY, 1890.
40. A. W. BUTLER, 1891.
41. T. H. NORTON, 1892.
42. H. LEROY FAIRCHILD, 1893.
43. JAS. LEWIS HOWE, 1894.
44. CHARLES R. BARNES, 1895.
45. ASAPH HALL, JR., 1896.
46. D. S. KELLICOTT,* 1897.
47. FREDERICK BEDELL, 1898.
48. CHARLES BASKERVILLE, 1899.
49. WILLIAM HALLOCK, 1900.
50. D. T. MACDOUGAL, 1901.
51. H. B. WARD, 1902.
52. CH. WARDELL STILES, 1903.
53. CHAS. S. HOWE, 1904.

Secretaries of Section A.—Mathematics, Physics and Chemistry, 1875–1881.

24. { S. P. LANGLEY, 1875.
    { T. C. MENDENHALL, 1875.
25. A. W. WRIGHT, 1876.
26. H. C. BOLTON, 1877.
27. F. E. NIPHER, 1878.
28. J. K. REES, 1879.
29. H. B. MASON, 1880.
30. E. T. TAPPAN, 1881, in the absence of JNO. TROWBRIDGE.

Secretaries of Section B.—Natural History, 1874–1881.

24. EDWARD S. MORSE, 1875.
25. ALBERT H. TUTTLE, 1876.
26. WILLIAM H. DALL, 1877.
27. GEORGE LITTLE, 1878.
28. WM. H. DALL, 1879, in the absence of A. C. WETHERBY.
29. CHARLES V. RILEY,* 1880.
30. WILLIAM SAUNDERS, 1881.

SECRETARIES OF SUBSECTIONS, 1875–1881.

Subsection of Chemistry.

24. F. W. CLARKE, 1875.
25. H. C. BOLTON, 1876.
26. P. SCHWEITZER, 1877.
27. A. P. S. STUART, 1878.
28. W. R. NICHOLS,* 1879.
29. C. E. MUNROE, 1880.
30. ALFRED SPRINGER, 1881, in the absence of R. B. WARDER.

Subsection of Entomology.

30. B. P. MANN, 1881.

Subsection of Anthropology.

24. F. W. PUTNAM, 1875.
25. OTIS T. MASON, 1876.
26, 27. United with Section B.
28, 29, 30. J. G. HENDERSON, 1879–81.

Subsection of Microscopy.

25. E. W. MORLEY, 1876.
26. T. O. SOMMERS, JR., 1877.
27. G. J. ENGELMANN, 1878.
28, 29. A. B. HERVEY, 1879–80.
30. W. H. SEAMAN, 1881, in the absence of S. P. SHARPLES.

SECRETARIES OF THE SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. H. T. EDDY, 1882.
32. G. W. HOUGH, 1883, in the absence of W. W. JOHNSON.
33. G. W. HOUGH, 1884.
34. E. W. HYDE, 1885.
35. S. C. CHANDLER, 1886.
36. H. M. PAUL, 1887.
37. C. C. DOOLITTLE, 1888.

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SECRETARIES OF THE SECTIONS, CONTINUED.

38. G. C. COMSTOCK, 1889.
39. W. W. BEMAN, 1890.
40. F. H. BIGELOW, 1891.
41. WINSLOW UPTON, 1892.
42. C. A. WALDO, 1893, in the absence of A. W. PHILLIPS.
43. J. C. KERSHNER, 1894, in place of W.W.BEMAN, res'd.
44. ASAPH HALL, JR., 1895, in place of E. H. MOORE, res'd.
45. EDWIN B. FROST, 1896.
46. JAMES MCMAHON, 1897.
47. WINSLOW UPTON, 1898, in place of ALEX. ZIWET, resigned.
48. JOHN F. HAYFORD, 1899.
49. W. M. STRONG, 1900.
50. G. A. MILLER, 1901, in place of H. C. LORD, resigned.
51. E. S. CRAWLEY, 1902.
52. C. S. HOWE, 1903.
53. L. G. WELD, 1904.

Section B.—Physics.

31. C. S. HASTINGS, 1882.
32. F. E. NIPHER, 1883, in the absence of C. K. WEAD.
33. N. D. C. HODGES, 1884.
34. B. F. THOMAS, 1885, in place. of A. A. MICHELSON, resigned.
35. H. S. CARHART, 1886.
36. C. LEO MEES, 1887.
37. ALEX. MACFARLANE, 1888.
38. E. L. NICHOLS, 1889.
39. E. M. AVERY, 1890.
40. ALEX. MACFARLANE, 1891.
41. BROWN AYRES, 1892.
42. W. LECONTE STEVENS, 1893.
43. B. W. SNOW, 1894.
44. E. MERRITT, 1895.
45. FRANK P. WHITMAN, 1896.
46. FREDERICK BEDELL, 1897.
47. W. S. FRANKLIN, 1898, in place of E. B. ROSA, resigned.
48. WILLIAM HALLOCK, 1899.
49. R. A. FESSENDEN, 1900.
50. JOHN ZELENY, 1901, in place of J. O. REED, resigned.
51. E. F. NICHOLS, 1902.
52. D. C. MILLER, 1903.
53. D. C. MILLER, 1904.

Section C.—Chemistry.

31. ALFRED SPRINGER, 1882.
32. J. W. LANGLEY, 1883. / W. MCMURTRIE, 1883.
33. H. CARMICHAEL, 1884, in the absence of R. B. WARDER.
34. F. P. DUNNINGTON, 1885.
35. W. MCMURTRIE, 1886.
36. C. F. MABERY, 1887.
37. W. L. DUDLEY, 1888.
38. EDWARD HART, 1889.
39. W. A. NOYES, 1890.
40. T. H. NORTON, 1891.
41. JAS. LEWIS HOWE, 1892.
42. H. N. STOKES, 1893, in the absence of J. U. NEF.
43. MORRIS LOEB, 1894, in place of S. M. BABCOCK, resigned.
44. W. P. MASON, 1895. / W. O. ATWATER, 1895.
45. FRANK P. VENABLE, 1896.
46. P. C. FREER, 1897.
47. C. BASKERVILLE, 1898.
48. H. A. WEBER, 1899.
49. A. A. NOYES, 1900.
50. W. MCPHERSON, 1901.
51. F. C. PHILLIPS, 1902.
52. H. N. STOKES, 1903.
53. A. H. GILL, 1904.

Section D.—Mechanical Science and Engineering.

31. J. BURKITT WEBB, 1882, in the absence of C. B. DUDLEY.
32. J. BURKITT WEBB, 1883, *pro tempore*.
33. J. BURKITT WEBB, 1884.
34. C. J. H. WOODBURY, 1885.
35. WILLIAM KENT, 1886.

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SECRETARIES OF THE SECTIONS, CONTINUED.

36. G. M. BOND, 1887.
37. ARTHUR BEARDSLEY, 1888.
38. W. B. WARNER, 1889.
39. THOMAS GRAY, 1890.
40. WILLIAM KENT, 1891.
41. O. H. LANDRETH, 1892.
42. D. S. JACOBUS, 1893.
43. JOHN H. KINEALY, 1894.
44. H. S. JACOBY, 1895.
45. JOHN GALBRAITH, 1896.
46. JOHN J. FLATHER, 1897.
47. JOHN J. FLATHER, 1898, in the absence of W. S. ALDRICH.
48. J. M. PORTER, 1899.
49. W. T. MAGRUDER, 1900.
50. C. W. COMSTOCK, 1901, in the absence of W. H. JAQUES.
51. C. A. WALDO, 1902.
52. ELWOOD MEAD, 1903, in the absence of ALBERT KINGSBURY.
53. W. T. MAGRUDER, 1904.

Section E.—Geology and Geography.

31. H. S. WILLIAMS, 1882, in the absence of C. E. DUTTON.
32. A. A. JULIEN, 1883.
33. E. A. SMITH, 1884.
34. G. K. GILBERT, 1885, in the absence of H. C. LEWIS.*
35. E. W. CLAYPOLE,* 1886.
36. W. M. DAVIS, 1887, in the absence of T. B. COMSTOCK.
37. JOHN C. BRANNER, 1888.
38. JOHN C. BRANNER, 1889.
39. SAMUEL CALVIN, 1890.
40. W J MCGEE, 1891.
41. R. D. SALISBURY, 1892.
42. W. H. HOBBS,* 1893, in place of R. T. HILL, resigned.
43. JED. HOTCHKISS,* 1894, in place of W. M. DAVIS, res'd
44. J. PERRIN SMITH, 1895.
45. W. N. RICE, 1896, in place of A. C. GILL, resigned.
46. C. H. SMITH, JR., 1897.
47. WARREN UPHAM, 1898.
48. ARTHUR HOLLICK, 1899.
49. J. A. HOLMES, 1900.
50. H. B. PATTON, 1901, in the absence of R. A. F. PENROSE.
51. F. P. GULLIVER, 1902.
52. E. O. HOVEY, 1903.
53. G. B. SHATTUCK, 1904.

Section F.—Biology, 1882–1892.

31. WILLIAM OSLER, 1882, in the absence of C. S. MINOT.
32. S. A. FORBES, 1883.
33. C. E. BESSEY, 1884.
34. J. A. LINTNER,* 1885, in place of C. H. FERNALD, res'd.
35. J. C. ARTHUR, 1886.
36. J. H. COMSTOCK, 1887.
37. B. E. FERNOW, 1888.
38. A. W. BUTLER, 1889.
39. J. M. COULTER, 1890.
40. A. J. COOK, 1891.
41. D. B. HALSTEAD, 1892.

Section F.—Zoology.

42. L. O. HOWARD, 1893.
43. JOHN B.SMITH, 1894, in place of WM.LIBBY, JR., resigned.
44. C. W. HARGITT, 1895, in place of S. A. FORBES, res'd.
45. D. S. KELLICOTT,* 1896.
46. C. C. NUTTING, 1897.
47. R. T. JACKSON, 1898, in place of C. W. STILES, resigned.
48. C. L. MARLATT, 1899, in place of F. W. TRUE, resigned.
49. C. H. EIGENMANN, 1900.
50. H. B. WARD, 1901.
51. C. W. STILES, 1902.
52. C. J. HERRICK, 1903.
53. C. J. HERRICK, 1904.

Section G.—Microscopy, 1882–85.

31. ROBERT BROWN, JR., 1882.

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SECRETARIES OF THE SECTIONS, CONTINUED.

32. CARL SEILER, 1883.
33. ROMYN HITCHCOCK, 1884.
34. W. H. WALMSLEY, 1885.

Section G.—Botany.

42. B. T. GALLOWAY, 1893, in the absence of F. V. COVILLE.
43. CHAS. R. BARNES, 1894.
44. B. T. GALLOWAY, 1895. / M. B. WAITE, 1895.
45. GEORGE F. ATKINSON, 1896.
46. F. C. NEWCOMBE, 1897.
47. ERWIN F. SMITH, 1898.
48. W. A. KELLERMAN, 1899.
49. D. T. MACDOUGAL, 1900.
50. ERNST A. BESSEY, 1901, in the absence of A. S. HITCHCOCK.
51. H. VON SCHRENK, 1902.
52. C. J. CHAMBERLAIN, 1903.
53. F. E. LLOYD, 1904.

Section H.—Anthropology.

31. OTIS T. MASON, 1882.
32. G. H. PERKINS, 1883.
33. G. H. PERKINS, 1884, in the absence of W. H. HOLMES.
34. ERMINNIE A. SMITH,* 1885.
35. A. W. BUTLER, 1886.
36. CHAS. C. ABBOTT, 1887, in the absence of F. W. LANGDON.
37. FRANK BAKER, 1888.
38. W. M. BEAUCHAMP, 1889.
39. JOSEPH JASTROW, 1890.
40. W. H. HOLMES, 1891.
41. W. M. BEAUCHAMP, 1892, in place of S. CULIN, resigned.
42. W. K. MOOREHEAD, 1893.
43. A. F. CHAMBERLIN, 1894.
44. STEWART CULIN and W. W. TOOKER, 1895, in place of ANITA N. MCGEE, res'd.
45. G. H. PERKINS, 1896, in place of J. G. BOURKE,* dec'd.
46. ANITA N. MCGEE, 1897, in place of HARLAN I. SMITH, resigned.
47. MARSHALL H. SAVILLE, 1898.
48. E. W. SCRIPTURE, 1899, in place of GEO. A. DORSEY, resigned.
49. FRANK RUSSELL, 1900.
50. G. G. MACCURDY, 1901.
51. HARLAN I. SMITH, 1902.
52. R. B. DIXON, 1903.
53. GEO. H. PEPPER.

Section I.—Social and Economic Science.

31. FRANKLIN B. HOUGH,* 1882. / J. RICHARDS DODGE, 1882.
32. JOSEPH CUMMINGS,* 1883.
33. CHARLES W. SMILEY, 1884.
34. CHAS. W. SMILEY, 1885, in the absence of J. W. CHICKERING.
35. H. E. ALVORD, 1886.
36. W. R. LAZENBY, 1887.
37. CHARLES S. HILL, 1888.
38. J. RICHARDS DODGE, 1889.
39. B. E. FERNOW, 1890.
40. B. E. FERNOW, 1891.
41. HENRY FARQUHAR, 1892, in place of L. F. WARD, made Vice-President.
42. NELLIE S. KEDZIE, 1893.
43. MANLEY MILES, 1894.
44. W. R. LAZENBY, 1895, in place of E. A. ROSS, resigned.
45. R. T. COLBURN, 1896.
46. ARCHIBALD BLUE, 1897.
47. MARCUS BENJAMIN, 1898.
48. CALVIN M. WOODWARD, 1899.
49. H. T. NEWCOMB, 1900.
50. R. A. PEARSON, 1901, in place of CORA A. BENNESON, resigned.
51. F. R. RUTTER, 1902, in place of Walter F. Willcox, resigned.
52. F. H. HITCHCOCK, 1903.
53. J. F. CROWELL, 1904.

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SECRETARIES OF THE SECTIONS, CONTINUED.

Section K.—Physiology and Experimental Medicine.

51. F. S. LEE, 1902.
52. F. S. LEE, 1903.
53. F. S. LEE, 1904.

TREASURERS.

1. JEFFRIES WYMAN,* 1848.
2. A. L. ELWYN,* 1849.
3. ST. J. RAVENEL,* 1850, in the absence of A. L. ELWYN.*
4. A. L. ELWYN,* 1850.
5. SPENCER F. BAIRD,* 1851, in the absence of A. L. ELWYN.*
6–7. A. L. ELWYN,* 1851–53.
8. J. L. LECONTE,* 1854, in the absence of A. L. ELWYN.*
9–19. A. L. ELWYN,* 1855–1870.
20–30. WM. S. VAUX,* 1871–1881.
32–42. WM. LILLY,* 1882–93.
43–49. R. S. WOODWARD, 1894–1900.
50–54. R. S. WOODWARD, 1901–1905.

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Commonwealth of Massachusetts.

In the Year One Thousand Eight Hundred and Seventy-Four.

AN ACT

TO INCORPORATE THE "AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE."

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:

SECTION 1. Joseph Henry of Washington, Benjamin Pierce of Cambridge, James D. Dana of New Haven, James Hall of Albany, Alexis Caswell of Providence, Stephen Alexander of Princeton, Isaac Lea of Philadelphia, F. A. P. Barnard of New York, John S. Newberry of Cleveland, B. A. Gould of Cambridge, T. Sterry Hunt of Boston, Asa Gray of Cambridge, J. Lawrence Smith of Louisville, Joseph Lovering of Cambridge, and John LeConte of Philadelphia, their associates, the officers and members of the Association, known as the "American Association for the Advancement of Science," and their successors, are hereby made a corporation by the name of the "American Association for the Advancement of Science," for the purpose of receiving, purchasing, holding, and conveying real and personal property, which it now is, or hereafter may be, possessed of, with all the powers and privileges, and subject to the restrictions, duties and liabilities set forth in the general laws which now or hereafter may be in force and applicable to such corporations.

SECTION 2. Said corporation may have and hold by purchase, grant, gift, or otherwise, real estate not exceeding one hundred thousand dollars in value, and personal estate of the value of two hundred and fifty thousand dollars.

SECTION 3. Any two of the corporators above named are hereby authorized to call the first meeting of the said corporation in the month of August next ensuing, by notice thereof "by mail," to each member of the said Association.

SECTION 4. This act shall take effect upon its passage.

HOUSE OF REPRESENTATIVES, March 10, 1874.
Passed to be enacted,
JOHN E. SANFORD, *Speaker.*

IN SENATE, March 17, 1874.
Passed to be enacted,
GEO. B. LORING, *President.*

March 19, 1874.
Approved.
W. B. WASHBURN.

SECRETARY'S DEPARTMENT,
Boston, April 3, 1874.
A true copy, Attest:
DAVID PULSIFER,
Deputy Secretary of the Commonwealth.

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CONSTITUTION

OF THE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Incorporated by Act of the General Court of the Commonwealth of Massachusetts.

OBJECTS.

ARTICLE 1. The objects of the Association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness.

MEMBERSHIP.

ART. 2. The Association shall consist of members, fellows, patrons, corresponding members and honorary fellows.

MEMBERS.

ART. 3. Any person may become a member of the Association upon recommendation in writing by two members or fellows, and election by the Council. Any incorporated scientific society or institution, or any public or incorporated library, may be enrolled as a member of the Association by vote of the Council by payment of the initiation fee; such society, institution, or library may be represented by either the President, Curator, Director, or Librarian presenting proper credentials at any meeting of the Association for which the assessment has been paid.

ASSOCIATES.

Associates for any single meeting shall be admitted on the payment of three dollars, such associates to have all the privileges of the meeting, except reading papers and voting.

Members of scientific societies whose meetings are contemporaneous with, or immediately subsequent to, that of the Associa-

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tion, and which are recognized by vote of the Council as "Affiliated Societies," may become associate members for that meeting on the payment of three dollars. They shall be entitled to all the privileges of membership except voting or appointment to office, but their names shall not appear in the list of members printed in the annual report.

Foreign Associates.

Any member or fellow of any national scientific or educational institution, or of any society or academy of science, of any country not in America, who may be present at any meeting of the Association shall, on presenting the proper credentials, be enrolled without fee as a Foreign Associate, and shall be entitled to all the privileges of the meeting except voting on matters of business.

Fellows.

Art. 4. Fellows shall be elected by the Council from such of the members as are professionally engaged in science, or have, by their labors, aided in advancing science. The election of fellows shall be by ballot, and a majority vote of the members of the Council at a designated meeting of the Council.

Patrons.

Art. 5. Any person paying to the Association the sum of one thousand dollars shall be classed as a patron, and shall be entitled to all the privileges of a member and to all its publications.

Honorary Fellows and Corresponding Members.

Art. 6. Honorary fellows of the Association, not exceeding three for each Section, may be elected, the nominations to be made by the Council and approved by ballot in the respective sections before election by ballot in General Session. Honorary fellows shall be entitled to all the privileges of fellows, and shall be exempt from all fees and assessments, and entitled to all publications of the Association issued after the date of their election. Corresponding members shall consist of such scientists not residing in America as may be elected by the Council, and their number shall be limited to fifty. Corresponding members shall be entitled to

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all the privileges of members and to the annual volumes of Proceedings published subsequent to their election.

SUSPENSIONS.

ART. 7. The name of any member or fellow two years in arrears for annual dues shall be erased from the list of the Association, provided, that two notices of indebtedness. at an interval of at least three months, shall have been given; and no such person shall be restored until he has paid his arrearages or has been re-elected. The Council shall have power to exclude from the Association any member or fellow, on satisfactory evidence that said member or fellow is an improper person to be connected with the Association, or has in the estimation of the Council made improper use of his membership or fellowship.

OFFICERS.

ART. 8. No member or fellow shall take part in the organization of, or hold office in, more than one section at any one meeting.

ART. 9. The officers of the Association shall be elected by ballot by the General Committee from the fellows, and shall consist of a President, a Vice-President from each section, a Permanent Secretary, a General Secretary, a Secretary of the Council, a Treasurer, and a Secretary of each Section; these, with the exception of the Permanent Secretary, the Treasurer, and the Secretaries of the Sections, shall be elected at each meeting for the following one, and, with the exception of the Treasurer and the Permanent Secretary, shall not be re-eligible for the next two meetings. The term of office of the Permanent Secretary, of the Treasurer, and of the Secretaries of the Sections, shall be five years.

PRESIDENT.

ART. 10. The President, or, in his absence, the senior Vice-President present, shall preside at all General Sessions of the Association and at all meetings of the Council. It shall also be the duty of the President to give an address at a General Session of the Association at the meeting following that over which he presided.

VICE-PRESIDENTS.

ART. 11. The Vice-Presidents shall be chairmen of their respective Sections, and of their Sectional Committees, and it

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shall be part of their duty to give an address, each before his own Section, at such time as the Council shall determine at the meeting subsequent to that at which he presides. The Vice-Presidents may appoint temporary chairmen to preside over the sessions of their sections, but shall not delegate their other duties. The Vice-Presidents shall have seniority in order of their continuous membership in the Association.

General Secretary.

Art. 12. The General Secretary shall be the Secretary of all General Sessions of the Association, and shall keep a record of the business of these sessions. He shall receive the records from the Secretaries of the Sections, which, after examination, he shall transmit with his own records to the Permanent Secretary within two weeks after the adjournment of the meeting.

Secretary of the Council.

Art. 13. The Secretary of the Council shall keep the records of the Council. He shall give to the Secretary of each Section the titles of papers assigned to it by the Council. He shall receive proposals for membership and bring them before the Council.

Permanent Secretary.

Art. 14. The Permanent Secretary shall be the executive officer of the Association under the direction of the Council. He shall attend to all business not specially referred to committees nor otherwise constitutionally provided for. He shall keep an account of all business that he has transacted for the Association, and make annually a general report for publication in the annual volume of Proceedings. He shall attend to the printing and distribution of the annual volume of Proceedings, and all other printing ordered by the Association. He shall issue a circular of information to members and fellows at least three months before each meeting, and shall, in connection with the Local Committee, make all necessary arrangements for the meetings of the Association. He shall provide the Secretaries of the Association with such books and stationery as may be required for their records and business, and shall provide members and fellows with such blank forms as may be required for facilitating the business of the Association. He shall collect all assessments

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and admission fees, and notify members and fellows of their election, and of any arrearages. He shall receive, and bring before the Council, the titles and abstracts of papers proposed to be read before the Association. He shall keep an account of all receipts and expenditures of the Association, and report the same annually at the first meeting of the Council, and shall pay over to the Treasurer such unexpended funds as the Council may direct. He shall receive and hold in trust for the Association all books, pamphlets, and manuscripts belonging to the Association, and allow the use of the same under the provisions of the Constitution and the orders of the Council. He shall receive all communications addressed to the Association during the intervals between meetings, and properly attend to the same. He shall at each meeting report the names of fellows and members who have died since the preceding meeting. He shall be allowed a salary which shall be determined by the Council, and may employ one or more clerks at such compensation as may be agreed upon by the Council.

TREASURER.

ART. 15. The Treasurer shall invest the funds received by him in such securities as may be directed by the Council. He shall annually present to the Council an account of the funds in his charge. No expenditure of the principal in the hands of the Treasurer shall be made without a unanimous vote of the Council, and no expenditure of the income received by the Treasurer shall be made without a two-thirds vote of the Council. The Treasurer shall give bonds for the faithful performance of his duty in such manner and sum as the Council shall from time to time direct.

SECRETARIES OF THE SECTIONS.

ART. 16. The Secretaries of the Sections shall keep the records of their respective Sections, and, at the close of the meeting, give the same, including the records of subsections, to the General Secretary. They shall also be the Secretaries of the sectional committees. The Secretaries shall have seniority in order of their continuous membership in the Association.

VACANCIES.

ART. 17. In case of a vacancy in the office of President, the senior Vice-President shall preside, as provided in Article 10,

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until the General Committee can be assembled and the vacancy filled by election. Vacancies in the offices of Vice-President, Permanent Secretary, Secretary of the Council, Secretaries of the Sections, and Treasurer, shall be filled by the Council by ballot.

COUNCIL.

ART. 18. The Council shall consist of the Past Presidents, and the Vice-Presidents of the last two meetings, together with the President, the Vice-Presidents, the Permanent Secretary, the General Secretary, the Secretary of the Council, the Secretaries of the Sections, and the Treasurer of the current meeting, of one fellow elected from each Section by ballot on the first day of its meeting, of one fellow elected by each affiliated society, and one additional fellow from each affiliated society having more than twenty-five members who are fellows of the Association, and of nine fellows elected by the Council, three being annually elected for a term of three years. The members present at any regularly called meeting of the Council, provided there are at least five, shall form a quorum for the transaction of business. The Council shall meet on the day preceding each annual meeting of the Association, and arrange the program for the first day of the sessions. The time and place of this first meeting shall be designated by the Permanent Secretary. Unless otherwise agreed upon, regular meetings of the Council shall be held in the Council room at 9 o'clock A. M., on each day of the meeting of the Association. Special meetings of the Council may be called at any time by the President. The Council shall be the board of supervision of the Association, and no business shall be transacted by the Association that has not first been referred to, or originated with, the Council. The Council shall decide which papers, discussions, and other proceedings shall be published, and have the general direction of the publications of the Association; manage the financial affairs of the Association; arrange the business and programs for General Sessions; suggest subjects for discussion, investigation or reports; elect members and fellows; and receive and act upon all invitations extended to the Association and report the same at a General Session of the Association. The Council shall receive all reports of Special Committees and decide upon them, and only such shall be read in General

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Session as the Council shall direct. The Council shall appoint at each meeting the following subcommittees who shall act, subject to appeal to the whole Council, until their successors are appointed at the following meeting: 1, on Papers and Reports; 2, on Members; 3, on Fellows.

General Committee.

ART. 19. The General Committee shall consist of the Council and one member or fellow elected by each of the Sections, who shall serve until their successors are elected. It shall be the duty of the committee to meet at the call of the President and elect the general officers for the following meeting of the Association. It shall also be the duty of this committee to fix the time and place for the next meeting. The Vice-President and Secretary of each Section shall be recommended to the General Committee by the Sectional Committee.

Meetings.

ART. 20. The Association shall hold a public meeting annually, for one week or longer, at such time and place as may be determined by vote of the General Committee, and the preliminary arrangements for each meeting shall be made by the Local Committee, in conjunction with the Permanent Secretary and such other persons as the Council may designate.

But if suitable preliminary arrangements cannot be made, the Council may afterward change the time and place appointed by the General Committee, if such change is believed advisable, by two-thirds of the members present.

ART. 21. A General Session shall be held at 10 o'clock, A. M., on the first day of the meeting, and at such other times as the Council may direct.

Sections and Subsections.

ART. 22. The Association shall be divided into Sections, namely:—A, *Mathematics and Astronomy;* B, *Physics;* C, *Chemistry, including its application to Agriculture and the Arts;* D, *Mechanical Science and Engineering;* E, *Geology and Geography;* F, *Zoology;* G, *Botany;* H, *Anthropology;* I, *Social and Economic Science;* K, *Physiology and Experimental Medicine.* The Council shall have

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power to consolidate any two or more Sections temporarily, and such consolidated Sections shall be presided over by the senior Vice-President and Secretary of the Sections comprising it.

SECTIONAL COMMITTEES.

ART. 23. Immediately on the organization of a Section there shall be a member or fellow elected by ballot after open nomination, who, with the Vice-President and Secretary and the Vice-President and Secretary of the preceding meeting, and the members or fellows elected by ballot at the four preceding meetings, shall form its Sectional Committee. The Sectional Committees shall have power to fill vacancies in their own numbers. Meetings of the Sections shall not be held at the same time with a General Session. The Sectional Committee may invite distinguished foreign associates present at any meeting to serve as honorary members of said Committee.

ART. 24. The Sectional Committee of any Section may at its pleasure form one or more temporary Subsections, and may designate the officers thereof. The Secretary of a Subsection shall, at the close of the meeting, transmit his records to the Secretary of the Section.

ART. 25. No paper shall be read in any Section or Subsection until it has been placed on the program of the day by the Sectional Committee.

ART. 26. The Sectional Committees shall arrange and direct the business of their respective Sections. They shall prepare the daily programs and give them to the Permanent Secretary for printing at the earliest moment practicable. No titles of papers shall be entered on the daily programs except such as have passed the Committee. No change shall be made in the program for the day in a Section without the consent of the Sectional Committee. The Sectional Committees may refuse to place the title of any paper on the program; but every such title, with the abstract of the paper or the paper itself, must be referred to the Council with the reasons why it was refused. The Sectional Committee shall also make nominations to the General Committee for Vice-President and Secretary of their respective Sections as provided for in Article 19.

ART. 27. The Sectional Committees shall examine all papers and abstracts referred to the Sections, and they shall not place

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on the program any paper inconsistent with the character of the Association; and to this end they have power to call for any paper, the character of which may not be sufficiently understood from the abstract submitted.

Papers and Communications.

Art. 28. All members and fellows must forward to the Secretary of the proper Section or to the Permanent Secretary, as early as possible. and when practicable before the convening of the Association, full titles of all the papers which they propose to present during the meeting, with a statement of the time that each will occupy in delivery, and also such abstracts of their contents as will give a general idea of their nature; and no title shall be considered by a Sectional Committee until an abstract of the paper or the paper itself has been received.

Art. 29. If the author of any paper be not ready when called upon, in the regular order of the official program, the title may be dropped to the bottom of the list.

Art. 30. Whenever practicable the proceedings and discussions at General Sessions, Sections and Subsections, shall be reported by professional reporters, but such reports shall not appear in print as the official reports of the Association unless revised by the Secretaries.

Printed Proceedings.

Art. 31. The Permanent Secretary shall have the Proceedings of each meeting printed in an octavo volume as soon after the meeting as possible, beginning one month after adjournment. Authors must prepare their papers or abstracts ready for the press, and these must be in the hands of the Secretaries of the Sections before the final adjournment of the meeting, otherwise only the titles will appear in the printed volume. The Council shall have power to order the printing of any paper by abstract or title only. Whenever practicable, proofs shall be forwarded to authors for revision. If any additions or substantial alterations are made by the author of a paper after its submission to the Secretary, the same shall be distinctly indicated. Illustrations must be provided for by the authors of the papers, or by a special appropriation from the Council. Immediately on publication of

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the volume, a copy shall be forwarded to every member and fellow of the Association who shall have paid the assessment for the meeting to which it relates, and it shall also be offered for sale by the Permanent Secretary at such price as may be determined by the Council. The Council shall also designate the institutions to which copies shall be distributed.

Local Committee.

ART. 32. The Local Committee shall consist of persons interested in the objects of the Association and residing at or near the place of the proposed meeting. It is expected that the Local Committee, assisted by the officers of the Association, will make all essential arrangements for the meeting, and issue a circular giving necessary particulars, at least one month before the meeting.

Library of the Association.

ART. 33. All books and pamphlets received by the Association shall be in charge of the Permanent Secretary, who shall have a list of the same printed and shall furnish a copy to any member or fellow on application. Members and fellows who have paid their assessments in full shall be allowed to call for books and pamphlets, which shall be delivered to them at their expense on their giving a receipt agreeing to make good any loss or damage, and to return the same free of expense to the Secretary at the time specified in the receipt given. All books and pamphlets in circulation must be returned at each meeting. Not more than five books, including volumes, parts of volumes, and pamphlets, shall be held at one time by any member or fellow. Any book may be withheld from circulation by order of the Council. [The Library of the Association was, by vote of the Council in 1895, placed on deposit in the Library of the University of Cincinnati, Ohio. Members can obtain the use of books by writing to the Librarian of the University Library, Cincinnati, Ohio.]

Admission Fee and Assessments.

ART. 34. The admission fee for members shall be five dollars in addition to the annual assessment. On the election of any member as a fellow an additional fee of two dollars shall be paid.

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ART. 35. The annual assessment for members and fellows shall be three dollars.

ART. 36. Any member or fellow who shall pay the sum of fifty dollars to the Association, at any one time, shall become a Life Member, and as such shall be exempt from all further assessments, and shall be entitled to the Proceedings of the Association. All money thus received shall be invested as a permanent fund, the income of which, during the life of the member, shall form a part of the general fund of the Association; but, after his death, shall be used only to assist in original research, unless otherwise directed by unanimous vote of the Council.

ART. 37. All fees and assessments must be paid to the Permanent Secretary, who shall give proper receipts for the same.

ACCOUNTS.

ART. 38. The accounts of the Permanent Secretary and of the Treasurer shall be audited annually by Auditors appointed by the Council.

ALTERATIONS OF THE CONSTITUTION.

ART. 39. No part of this Constitution shall be amended or annulled, without the concurrence of three-fourths of the members and fellows present in General Session, after notice given at a General Session of a preceding meeting of the Association.

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MEMBERS AND FELLOWS

OF THE

AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE.

(CORRECTED TO JUNE 15, 1903.)

SURVIVING FOUNDERS.

[At the Brooklyn Meeting, 1894, a resolution was unanimously adopted by which all the surviving founders of the Association who have maintained an interest in science were made Honorary Life Members of the Association in recognition of their pioneer work in American Science.]

ABBOT, SAMUEL L., Boston, Mass.
BOYÉ, MARTIN H., Coopersburg, Pa.
GIBBS, WOLCOTT, Newport, R. I.

PATRONS.

[Persons contributing one thousand dollars or more to the Association are classed as Patrons, and are entitled to the privileges of members and to the publications. The names of Patrons are to remain permanently on the list.]

THOMPSON, MRS. ELIZABETH, Stamford, Conn. (22). (Died July, 1899.)

LILLY, GEN. WILLIAM, Mauch Chunk, Pa. (28). (Died Dec. 1, 1893.)

HERRMAN, MRS. ESTHER, 59 West 56th St., New York, N. Y. (29).

MCMILLIN, EMERSON, 40 Wall St., New York, N. Y. (37).

HONORARY FELLOWS.

[See ARTICLE VI of the Constitution.]

*ROGERS, PROF. WILLIAM B., Boston, Mass. (1). 1881. (Born Dec. 7, 1804. Died May 30, 1882.) **B E**

*CHEVREUL, MICHEL EUGENE, Paris, France. (35). 1886. (Born Aug. 31, 1786. Died April 9, 1889.) **C**

*GENTH, DR. F. A., Philadelphia, Pa. (24). 1888. (Born May 17, 1820. Died Feb. 2, 1892.) **C E**

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*HALL, PROF. JAMES, Albany, N. Y. (1). 1890. (Born in 1811. Died Aug. 7, 1898.)

*GOULD, DR. BENJAMIN APTHORP, Cambridge, Mass. (2). 1895. (Born Sept. 27, 1824. Died Nov. 26, 1896.) **A B**

*LEUCKART, PROF. RUDOLF. (44). 1895. (Born in Helmstedt, Braunschweig, Germany, Oct. 7, 1823. Died in Leipzig, Feb. 7, 1898.) **F**

*GIBBS, PROF. WOLCOTT, Newport, R. I. (1). 1896. **B C**

*WARINGTON, ROBERT, F. R. S., Rothamsted, Harpenden, England. (40). 1899. **C**

*WESTINGHOUSE, GEORGE, Pittsburg, Pa. (50). 1902. **D**

MEMBERS AND FELLOWS.

The names designated by an asterisk (*) are those of Fellows. (See ARTICLE IV of the Constitution.) The number in parenthesis indicates the meeting at which the Member joined the Association; the date following is the year when made a Fellow; the black letters at end line are those of the Sections to which the Member or Fellow belongs. When the name is given in small capitals, it designates that the Member or Fellow is also a Life Member. Any Member or Fellow may become a Life Member by the payment of fifty dollars. The income of the money derived from a life membership is used for the general purposes of the Association during the life of the Member; afterwards it is to be used to aid in original research. Life Members are exempt from the annual assessment, and are entitled to the publications. The names of Life Members are printed in small capitals in the regular list of Members and Fellows.

The Constitution requires that the names of all Members two years in arrears shall be omitted from the list, but their names will be restored on payment of arrearages. Members not in arrears are entitled to the publications of the Association, including the journal *Science*.

*Abbe, Cleveland, Professor of Meteorology, Weather Bureau, U. S. Dept. Agriculture, Washington, D. C. (16). 1874. **A B**

*Abbe, Cleveland, Jr., 2017 I St., N. W., Washington, D. C. (44). 1899. **E**

Abbe, Truman, M. D., 2017 I St., N. W., Washington, D. C. (52) **K**

*Abbe, Dr. Robert, 13 W. 50th St., New York, N. Y. (36). 1892.

*Abbot, Charles G., Smithsonian Institution, Washington, D. C. (49). 1902. **B**

Abbot, Francis Ellingwood, Ph.D., 43 Larch Road, Cambridge, Mass. (50). **I**

*ABBOT, DR. SAMUEL L., 90 Mt. Vernon St., Boston, Mass. (1). 1898.

Abbott, Alexander C., Univ. of Penna., Philadelphia, Pa. (52). **K**

Abbott, Frank L., Professor of Physical Science, State Normal School, Greeley, Colo. (50). **B E**

Abbott, Theodore Sperry, C. E., Saltillo, Coahuila, Mexico. (52). **D**

*Abel, John J., Professor of Pharmacology, Johns Hopkins University, Baltimore, Md. (51). 1902. **C**

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*Abert, S. Thayer, Metropolitan Club, Washington, D. C. (30). 1891. **A B E**

Abraham, Abraham, Brooklyn, N. Y. (43).

Acheson, Edward Goodrich, President of the International Acheson Graphite Co., Niagara Falls, N. Y. (50). **C**

*Adams, Charles C., University of Michigan, Ann Arbor, Mich. (50). 1903. **F**

Adams, Comfort A., 13 Farrar St., Cambridge, Mass. (47).

Adams, C. E., M. D., 29 West Broadway, Bangor, Me. (43). **F**

Adams, Edward Dean, 35 Wall St., New York, N. Y. (49).

Adams, Ernest Kempton, 455 Madison Ave., New York, N. Y. (50). **D E**

Adams, Frederick C., Classical High School, Providence, R. I. (50). **B C**

*Adler, I., M. D., 12 E 60th St., New York, N. Y. (49). 1903. **K**

*Adriance, John S., 105 E. 39th St., New York, N. Y. (39). 1895. **C**

Ailes, Hon. Milton E., Assistant Secretary of the Treasury, Washington, D. C. (52). **I**

Ainsworth, Herman Reeve, M. D., Addison, N. Y. (51). **I K**

Akeley, Lewis E., Professor of Physics and Chemistry, University of South Dakota, Vermillion, S. Dak. (51). **B C**

Albaugh, Maurice, Secretary of the Crescent Metallic Fence Stay Co., Covington, Ohio. (51). **D**

Albrecht, Emil Poole, Secretary of The Bourse, 1523 N. 17th St., Philadelphia, Pa. (51). **A D**

Albrecht, Sebastian, 767 Forest Home, Milwaukee, Wis. (52). **A**

Albree, Chester B., Mechanical Engineer, 14–30 Market St., Allegheny, Pa. (50). **D**

*Alden, John, Pacific Mills, Lawrence, Mass. (36). 1898.

Alderson, Victor C., Dean of the Technical College, Armour Institute of Technology, Chicago, Ill. (50). **D**

*Aldrich, Wm. S., Director, Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y. (43). 1897. **D**

Alexander, Chas. Anderson, M. E., Johnston Harvester Co., 10 Vine St., Batavia, N. Y. (50). **D**

Alexander, Curtis, Mining Engineer, Cedral, San Luis Potosi, Mexico. (50). **E**

Alexander, George E., Chemist and Mining Engineer, 1736 Champa St., Denver, Colo. (50). **C D**

Alexander, Harry, E. E., M. E., 18 and 20 W. 34th St., New York, N. Y. (50). **D**

Aley, Robert J., Indiana Univ., Bloomington, Ind. (49).

Allabach, Miss Lulu F., Instructor in Biology and Zoology. Central State Normal School, Lock Haven, Pa. (52). **F**

Allan, Chas. F., Newburgh, N. Y. (50). **B E**

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Allderdice, Wm. H., Lieutenant U. S. Navy, Navy Dept., Washington, D. C. (33). **D**

Alleman, Gellert, Ph. D., Swarthmore College, Swarthmore, Pa. (50). **C**

Allen, C. L., Floral Park, N. Y. (49).

Allen, Charles Metcalf, Assistant Prof. of Experimental Engineering, Worcester Polytechnic Institute, Worcester, Mass. (52). **D**

Allen, Edwin West, Editor of *Experiment Station Record*, U. S. Dept. Agriculture, Washington, D. C. (52). **I**

*Allen, Frank, Ph. D., Cornell University, Ithaca, N. Y. (49). 1903. **B**

Allen, Hon. F. I., Commissioner of Patents, Washington, D. C. (52). **I**

Allen, Glover Morrill, Secretary Boston Soc. Nat. Hist., Perkins Hall 68, Cambridge, Mass. (52). **F**

Allen, H. Jerome, M. D., 421 H St., N.E., Washington, D. C. (51). **K**

Allen, Miss Jessie Blount, Univ. of Chicago, Chicago, Ill. (52). **F**

Allen, J. M., President of the Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn. (22). **D**

Allen, John Robins, Asst. Prof. of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. (45). **B D**

Allen, Richard H., Chatham, N. J. (49).

Allen, Walter S., 34 S. Sixth St., New Bedford, Mass. (39). **C I**

Allison, Charles Edward, M. D., Elysburg, Pa. (51). **K**

Allison, Hendery, M. D., 260 West 57th St., New York, N. Y. (50). **K**

Allyn, G. W., M. D., Secretary Academy of Science and Art, 515 Penn Ave., Pittsburg, Pa. (51). **F**

Almond, Thomas R., M. E., 83–85 Washington St., Brooklyn, N. Y. (51). **D**

*Almy, John E., Ph. D., Instructor in Physics, University of Nebraska, Lincoln, Neb. (50). 1901. **B**

Alpers, Wm. C., 45 West 31st St., New York, N. Y. (50). **I**

Alsop, E. B., 1502 20th St., N. W., Washington, D. C. (50). **D**

Alspach, E. F., 455 West Sixth Ave., Columbus, O. (48). **H**

*Alvord, Maj. Henry E., U. S. Dept. Agriculture, Washington, D. C. (29). 1882. **I**

*Alwood, Prof. Wm. B., Virginia Polytechnic Institute, Blacksburg, Va. (39). 1891. **F**

Ames, Oakes, Assistant Director of the Botanic Garden of Harvard University, North Easton, Mass. (50). **G**

Ammons, Miss Theodosia G., Professor of Domestic Science, State Agricultural College, Fort Collins, Colo. (50). **I**

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Amundson, John A., 146 Broadway, New York, N. Y. (49).
Amweg, Frederick James, Civil and Consulting Engineer, Box 537, Honolulu, H. T. (51). **D**
Anders, Howard S., M. D., 1836 Wallace St., Philadelphia, Pa. (51). **K**
Anderson, A. J. C., 127 Water St., New York, N. Y. (49).
*Anderson, Alexander P., American Cereal Co., Monadnock Building, Chicago, Ill. (45). 1899. **G**
Anderson, Prof. Douglas S., Tulane Univ., New Orleans, La. (49). **B D**
Anderson, Edwin Clinton, M. D., 726 Market St., Chattanooga, Tenn. (51). **K**
Anderson, Frank, E. M., 255 Second East St., Salt Lake City, Utah, (50). **D E**
Anderson, Frank P., Epworth, Iowa. (46).
Anderson, J. Hartley, M. D., 4630 Fifth Ave., Pittsburg, Pa. (50). **K**
Anderson, James Thomas, Lieutenant U. S. Army, 1112 N. Cascade Ave., Colorado Springs, Colo. (51).
Anderson, Winslow, M. D., President of College of Physicians and Surgeons of San Francisco, 1025 Sutter St., San Francisco, Cal. (51). **K**
Andrews, Frank Marion, Ph. D., Instructor in Botany, Indiana University, Bloomington, Ind. (52). **G**
Andrews, Wm. C., Columbia Univ., New York, N. Y. (46).
Andrews, Wm. Edward, Principal Township High School, 700 South Clay St., Taylorville, Ill. (52). **D**
Andrews, William Symes, care Gen'l Elec. Co., Schenectady, N. Y. (50). **D E**
Annear, John Brothers, Wallstreet, Colo. (50). **C**
Anthony, Mrs. Emilia C., Gouverneur, N. Y. (47). **G**
Anthony, Richard A., 122–124 Fifth Ave., New York, N. Y. (49).
*Anthony, Prof. Wm. A., Cooper Union, New York, N. Y. (28). 1880. **B**
Apple, Joseph H., President of the Woman's College, Frederick, Md. (52). **I**
*Appleton, John Howard, Professor of Chemistry, Brown University, Providence, R. I. (50). 1901. **C**
Archer, George Frost, 31 Burling Slip, New York, N. Y. (50). **D**
Armitage, Thomas L., M. D., Princeton, Minnesota. (51). **K**
Armsby, Henry Prentiss, Director Agrl. Expr. Station, State College, Centre Co., Pa. (52). **C**
Armstrong, Robert, M. D., Boulder, Colo. (50). **H K**
Arnold, Bion Joseph, 4128 Prairie Ave., Chicago, Ill. (50). **D**
Arnold, Delos, Pasadena, Cal. (51).

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Arnold, Ernst Hermann, M. D., Director New Haven Normal School of Gymnastics, 46 York Square, New Haven, Conn. (52). K

Arnold, Mrs. Francis B., 101 W. 78th St., New York, N. Y. (49).

Arnold, Jacob H., Teacher of Natural Science, Redfield College, Redfield, South Dakota. (50). I

Arnold, Ralph, Assistant in Geology, Stanford University, Cal. (51). E

*Arthur, J. C., Lafayette, Ind. (21). 1883. G

Asdale, William James, M. D., Professor of Gynecology, Western Penna. Medical College, Pittsburg, Pa. (51). K

Ashbrook, Donald Sinclair, 3614 Baring St., Philadelphia, Pa. (51). C

Ashcraft, A. M., Ph.D., P. O. Box 742, Baltimore, Md. (52).

Ashe, W. Willard, Consulting Forester, Raleigh, N. C. (47).

*Ashley, George Hall, Professor of Biology and Geology, College of Charleston, Charleston, S. C. (51). 1903. E F

*Ashmead, Wm. H., Department of Insects, U. S. National Museum, Washington, D. C. (40). 1892. F

Aspinwall, John, 290 Broadway, New York, N. Y. (49).

Atkins, Prof. Martin D., Professor of Physics and Electrical Engineering, Agricultural College, Mich. (48). B

*Atkinson, Edward, 31 Milk St., Boston, Mass. (29). 1881. D I

*Atkinson, George F., Cornell University, Ithaca, N. Y. (39). 1892. G

Atkinson, John B., Earlington, Ky. (26). D

*Atwater, W. O., Professor of Chemistry, Wesleyan Univ., Middletown, Conn. (29). 1882. C

*Atwell, Charles B., Northwestern Univ., Evanston, Ill. (36). 1890. G

*Auchincloss, Wm. S., 36 W. 12th St., New York, N. Y. (29). 1886. A D

*Austen, Prof. Peter T., 80 Broad St., New York, N. Y. (44). 1896. C

Austin, Oscar P., Chief Bureau of Statistics, Treasury Dept., Washington, D. C. (51). I

*Avery, Elroy M., Ph. D., LL.D., 657 Woodland Hills Ave., Cleveland, Ohio. (37). 1889. B

Avery, Samuel P., 4 E. 38th St., New York, N. Y. (36).

Ayer, Edward Everett, 915 Old Colony Bldg., Chicago, Ill. (37). H

Ayer, James I., 5 Main St. Park, Malden, Mass. (50). D

*Ayers, Howard, President Univ. of Cincinnati, Cincinnati, Ohio. (49). 1901. F

Aylesworth, Barton O., President of the State Agricultural College, Fort Collins, Colo. (50). I

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*Ayres, Prof. Brown, Tulane University, New Orleans, La. (31). 1885. **B**

Ayres, Horace B., U. S. Geological Survey, Washington, D. C. (40).

Babcock, Charles A., Supt. Schools, Oil City, Pa. (52). **F**

Babcock, Stephen E., Chief Engineer, Mohawk River Improvement, 54-56 Mann Bldg., Utica, N. Y. (51). **D**

*Babcock, Prof. S. Moulton, 432 Lake St., Madison, Wis. (33). 1885. **C**

Baerecke, John F., M. D., Professor of Biology, Stetson University, DeLand, Fla. (50). **F K**

Bagby, J. H. C., Dept. Physical Science, Hampden-Sidney College, Hampden-Sidney, Va. (50). **B**

*Bagg, Rufus Mather, Jr., Ph. D., High School, Brockton, Mass. (49). 1903. **E**

BAGGALEY, RALPH, Pittsburg, Pa. (50). **D**

*Bailey, E. H. S., Professor of Chemistry, Univ. of Kansas, Lawrence, Kan. (25). 1889. **C E**

Bailey, E. P., In charge Department of Science, Wakefield High School, 102 Railroad St., Wakefield, Mass. (52). **F**

Bailey, Frank H., Lieut. Com'dr, U. S. N., Bureau of Steam Engineering, Navy Dept., Washington, D. C. (52). **D**

*Bailey, Solon Irving, Associate Prof. Astronomy, Harvard Observatory, Cambridge, Mass. (50). 1901. **A**

Bailey, Vernon, Department of Agriculture, Washington, D. C. (52). **F**

*Bain, Samuel M., Professor of Botany, University of Tennessee, Knoxville, Tenn. (50). 1902. **G**

Baker, A. G., Springfield, Mass. (44).

*Baker, Frank, M. D., 1728 Columbia Road, Washington, D. C. (31). 1886. **F H K**

Baker, Frederic, 815 Fifth Ave., New York, N. Y. (49).

Baker, Hugh P., Yale Forest School, New Haven, Conn. (51). **G**

*Baker, James H., President of the University of Colorado, Boulder, Colo. (50). 1903. **I**

*Baker, Marcus, U. S. Geol. Survey, Washington, D. C. (30). 1882. **A**

Baker, Theodore, Box 44, Haskell, N. J. (51). **A**

*BALCH, EDWIN SWIFT, 1412 Spruce St., Philadelphia, Pa. (51). 1903. **E H**

Balch, Francis Noyes, Prince St., Jamaica Plain, Mass. (50). **F**

Balch, Samuel W., 67 Wall St., New York, N. Y. (43).

Baldwin, Mrs. G. H., 3 Madison Ave., Detroit, Mich. (34). **H**

Baldwin, Herbert B., 9-11 Franklin St., Newark, N. J. (43).

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*Baldwin, Prof. J. Mark, Princeton, N. J. (46). 1898. H

*Baldwin, Hon. Simeon E., Associate Judge of Supreme Court of Errors, New Haven, Conn. (50). 1901. I

*Baldwin, S. Prentiss, 736 Prospect St., Cleveland, Ohio. (47), 1900. E

Baldwin, William Dickson, 25 Grant Place, Washington, D. C. (52). E

*Ball, Carleton R., U. S. Dept. Agriculture, Washington, D. C. (49). 1902. G

*Ball, Elmer Darwin, Professor of Animal Biology, State Agricultural College, Logan, Utah. (50). 1903. F

Ball, Miss Helen Augusta, 43 Laurel St., Worcester, Mass. (50). F

Ballard, C. A., Curator of Museum, State Normal School, Moorhead, Minn. (51).

*Ballard, Harlan H., 50 South St., Pittsfield, Mass. (31). 1891. E F

Balliet, Thomas M., Supt. of Schools, Springfield, Mass. (48). H I

Bancroft, Alonzo C., Elma, New York. (41).

Bancroft, Frank Watts, Ph. D., Instructor in Physiology, University of California, Berkeley, Cal. (50). F K

Bancroft, John Sellers, M. E., 3310 Arch St., Philadelphia, Pa. (51). D

*Bancroft, Wilder Dwight, Professor of Chemistry, Cornell University, Ithaca, N. Y. (50). 1901. B C

Bangs, Lemuel Bolton, M. D., 127 E. 34th St., New York, N. Y. (36).

*Bangs, Outram, 240 Beacon St., Boston, Mass. (47). 1900. F

Banker, Howard J., Prof. Biology, Southwestern Normal School, California, Pa. (51). G

Banks, William C., Electrician, Gordon Battery Co., 439 E. 144th St., New York, N. Y. (50). D

Barber, Amzi L., 7 E. 42d St., New York, N. Y. (49).

*Barbour, Prof. Erwin Hinckley, Univ. of Nebraska, Lincoln, Neb. (45). 1898. E

Barbour, Thomas, 50 White St., New York, N. Y. (50). F

*Bardeen, Charles Russell, Anatomical Laboratory, Wolfe and Monument Sts., Baltimore, Md. (50). 1901. F K

Bardeen, Charles William, 406 So. Franklin St., Syracuse, N. Y. (52).

Bardwell, Darwin L., District Supt. of Schools, Borough of Richmond, Stapleton, N. Y. (52).

Barkan, Adolph, M. D., LL.D., Mutual Savings Bank Bldg., San Francisco, Cal. (51). K

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*Barker, Prof. G. F., 3909 Locust St., Philadelphia, Pa. (13). 1875. B C

Barker, Mrs. Martha M., 42 Eleventh St., Lowell, Mass. (31). E H

Barlow, John, A. M., State College of Agriculture, Kingston, R. I. (51). F

*Barnard, Edward E., Yerkes Observatory, Williams Bay, Wis. (26). 1883. A

Barnes, Albert, Clemson College, S. C. (49). D

*Barnes, Charles Reid, Ph. D., Univ. of Chicago, Chicago, Ill. (33). 1885. G

Barnes, Edward W., Box 446, New York, N. Y. (49).

Barnett, Robert Crary, 3023 East 20th St., Kansas City, Mo. (51). D

Barnhart, Arthur M., 185 Monroe St., Chicago, Ill. (42).

*Barnhart, John H., M. D., Tarrytown, N. Y. (49). 1903. G

Barnsley, George Thomas, C. E., Oakmont, Pa. (51). D

*Barnum, Miss Charlotte C., Ph. D., U. S. Coast and Geodetic Survey, Washington, D. C. (36). 1896. A

Barr, Charles Elisha, Professor of Biology, Albion College, Albion, Mich. (50). F

Barr, John Henry, Professor of Machine Design, Cornell University, Ithaca, N. Y. (51). D

Barrell, Joseph, Asst. Professor of Geology, Lehigh University, South Bethlehem, Pa. (51). E

Barrie, Dr. George, Johns Hopkins Univ., Baltimore, Md. (49). H I

Barringer, Daniel Moreau, Geologist and Mining Engineer, 460 Bullitt Building, Philadelphia, Pa. (50). D E

Barrows, Franklin W., M. D., 45 Park St., Buffalo, N. Y. (47). F

*Barrows, Walter B., Agricultural College, Mich. (40). 1897. F

*Bartlett, Prof. Edwin J., Dartmouth College, Hanover, N. H. (28). 1883. C

Bartlett, Francis, 40 State St., Boston, Mass. (50). I

Bartlett, George Miller, Instructor in Physics and Mathematics, Case School, Cleveland, Ohio. (52). B

*Bartlett, John R., Captain, U. S. N., 1622 21st St., N.W., Washington, D. C. (30). 1882. B E

*Bartley, Elias H., M. D., 21 Lafayette Ave., Brooklyn, N. Y. (33). 1894. C

*Barton, G. E., 212 North 3d St., Millville, N. J. (46). 1898. C

*Barton, George Hunt, Dept. of Geology, Mass. Inst. Tech., Boston, Mass. (47). 1900. E

Barton, Philip Price, E. E., Sup't Niagara Falls Power Co., 127 Buffalo Ave., Niagara Falls, N. Y. (50). D E

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*Barton, Samuel M., Ph. D., The Univ. of the South, Sewanee, Tenn. (43). 1899. **A**

Bartow, Edward, Ph. D., Kansas State University, Lawrence, Kan. (47). **C**

Bartsch, Paul, Ph. D., Instructor in Zoology, Columbian Univ., Washington, D. C. (52). **F**

*Barus, Carl, Ph. D., Wilson Hall, Brown Univ., Providence, R. I. (33). 1887. **B**

Barwell, John William, Waukegan, Ill. (47).

*Bascom, Miss Florence, Bryn Mawr College, Bryn Mawr, Pa. (42). 1897. **E**

Bashore, Dr. Harvey B., West Fairview, Pa. (46). **E**

*Baskerville, Charles, Univ. of North Carolina, Chapel Hill, N. C. (41). 1894. **C E**

Baskett, James Newton, Mexico, Mo. (50). **F I**

Bassett, Carroll Phillips, Ph. D., Civil and Consulting Engineer, Summit, N. J. (51). **D**

Bates, Henry H., Ph. D., The Portland, Washington, D. C. (52). **A B D**

Bates, Rev. John Mallery, Red Cloud, Neb. (51). **G I**

Bauder, Arthur Russell, Instructor in Physics, Boardman High School, New Haven, Conn. (50). **B**

*Bauer, Louis A., Ph. D., U. S. C. and G. Survey, Washington, D. C. (40). 1892. **A**

Baumgardt, B. R., 626 W. 30th St., Los Angeles, Cal. (51). **A**

*Bausch, Edw., P. O. Drawer 1033, Rochester, N. Y. (26). 1883. **A B C F**

Bausch, Henry, P. O. Drawer 1033, Rochester, N. Y. (41).

Bawden, H. Heath, Professor of Psychology and Philosophy, Vassar College, Poughkeepsie, N. Y. (51). **F**

Baxter, James Phinney, President, Maine Historical Society, Portland, Maine. (50). **H I**

Beach, Miss Alice M., St. Anthony Park, Minn. (50). **F**

Beach, Charles Coffing, M. D., 54 Woodland St., Hartford, Conn. (50). **F K**

Beach, Henry Harris Aubrey, M. D., 28 Commonwealth Ave., Boston, Mass. (50). **F K**

*Beach, Spencer Ambrose, N. Y. Agric. Exper. Station, Geneva, N. Y. (41). 1900. **G**

Beach, William Harrison, Teacher of History and Civics, East Division High School, 229 Pleasant St., Milwaukee, Wis. (52)

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*Beal, Wm. James, Ph. D., Professor of Botany, Agricultural College, Mich. (17). 1880. G

Beaman, George Herbert, 2232 Mass. Ave., N.W., Washington, D. C. (52). I

*Beardsley, Arthur E., Professor of Biology, Colorado State Normal School, Greeley, Colo. (50). 1901. F

Beates, Henry, Jr., M. D., President of State Board of Medical Examiners, 1504 Walnut St., Philadelphia, Pa. (51). K

Beatty, James W. F., Pitcairn, Pa. (51).

Bebb, Edward C., U. S. Geological Survey, Washington, D. C. (52). E

Becher, Franklin A., 234 Oneida St., Milwaukee, Wis. (41). A I

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*Becker, Dr. Geo. F., U. S. Geol. Survey, Washington, D. C. (36). 1890. E

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*Bell, Alex. Melville, 1525 35th St., Washington, D. C. (31). 1885. H

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*Bell, Robert, M. D., LL.D., F. R. S., Geol. Survey, Ottawa, Can. (38). 1889. E F

Bellows, Horace M., M. D., Huntingdon Valley, Pa. (51). K

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*Benjamin, Rev. Raphael, 662 Bedford Ave., Brooklyn, N. Y. (34). 1887. **E F G H**
*Benneson, Miss Cora Agnes, A. M., LL. B., 4 Mason St., Cambridge, Mass. (47). 1899. **H I**
Bennett, Charles W., Coldwater, Mich. (50). **E**
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Bennett, William Z., Ph. D., Director of Chemical Laboratory, Univ. of Wooster, Wooster, Ohio. (48). **C**
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Bentley, Wilson A., Nashville, Vt. (48).
Bentley, Wray Annin, Instructor in Metallurgy, School of Applied Science, Columbia University, New York, N. Y. (50). **E**
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*Bergey, David H., S. E. cor. 34th and Locust Sts., Philadelphia, Pa. (48). 1903. **K**
*Bergström, John Andrew, Ph. D., Associate Professor of Psychology and Pedagogy, Indiana University, Bloomington, Ind. (50). 1901. **I**
Berkeley, Wm. N., Ph. D., Box 65, San Juan, Porto Rico. (49). **C**
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Bernays, Augustus Charles, M. D., 3623 Laclede Ave., St. Louis, Mo., (50). **F K**
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Berry, Daniel, M. D., Carmi, Ill. (41). **B C E**
Berry, Edgar H., care C. W. Hunt Co., West New Brighton, N. Y. (50). **D**
Berry, Edward W., News Building, Passaic, N. J. (50). **I**
Berry, John Wilson, C. E., Pittston, Pa. (47).
*Bessey, Charles Edwin, Ph. D., LL.D., Univ. of Nebraska, Lincoln, Neb. (21). 1880. **G**

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Best, John E., M. D., Arlington Heights, Ill. (51). E F H K

Bethea, Solomon Hix, U. S. Attorney, Chicago Club, Chicago, Ill. (50). I

Bevier, Miss Isabel, Univ. of Illinois, Urbana, Ill. (46). C

*Beyer, Prof. Samuel W., Iowa Agricultural College, Ames, Iowa. (47). 1900. E

Beyer, T. Raymond, C. E., 119 Maplewood Ave., Germantown, Pa. (52).

*Bickmore, Prof. Albert S., Amer. Mus. Nat. History, Central Park, New York, N. Y. (17). 1880. H

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*Bigelow, Prof. Frank H., U. S. Weather Bureau, Washington, D. C. (36). 1888. A

Bigelow, Henry Bryant, Cohasset, Mass. (52).

*Bigelow, Maurice Alpheus, Ph. D., Instructor in Biology, Teachers' College, Columbia Univ., New York, N. Y. (51). 1903. F

*Bigelow, Robert P., Ph. D., Mass. Institute of Technology, Boston, Mass. (51). 1903. F

Bigelow, Samuel Lawrence, Ph. D., Asst. Professor of General Chemistry, University of Michigan, Ann Arbor, Mich. (51). C

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Biggs, Charles, 13 Astor Place, New York, N. Y. (50). I

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Billings, Miss E., 279 Madison Ave., New York, N. Y. (50). I

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Blackburn, Joseph E., State Dairy and Food Commissioner, Columbus, Ohio, (50). **F I**

*Blackmar, Frank Wilson, Professor of Sociology and Economics, University of Kansas, Lawrence, Kan. (50). 1903. **H I**

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Blackshear, Edward Levoisier, Principal of the Prairie View State Normal and Industrial College, Prairie View, Texas. (52). **H I**

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Blair, Mrs. Eliza N., Manchester, N. H. (40).

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*Blake, Francis, Auburndale, Mass. (23). 1874. **A B**

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Blauvelt, Harrington, Mining Engineer, Prescott, Arizona, (51). **D E**

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BLISH, W. G., Niles, Mich. (33). B D

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*Boas, Dr. Franz, Am. Mus. Nat. History, Central Park, New York, N. Y. (36). 1888. H I

*Bodine, Prof. Donaldson, Wabash College, Crawfordsville, Ind. (45). 1899. E F

*Bogert, Marston Taylor, Havemeyer Hall, Columbia Univ., New York, N. Y. (47). 1900. C

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*Bolley, Henry L., Agricultural College, North Dakota. (39). 1892. G

*BOLTON, DR. H. CARRINGTON, Cosmos Club, Washington, D. C. (17). 1875. C

*Bolton, Thaddeus L., Ph. D., Dept. Philosophy, University of Nebraska, Lincoln, Neb. (50). 1901. H I

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*Bouton, Charles Leonard, Instructor in Mathematics, Harvard University, Cambridge, Mass. (50). 1901. A.

Boutwell, John Mason, U. S. Geol. Survey, Washington, D. C. (46). E

*Bowditch, Charles P., 28 State St., Boston, Mass. (43). 1897. H

Bowditch, Miss Charlotte, Pond St., Jamaica Plain, Mass. (50). I

*Bowditch, Prof. H. P., Jamaica Plain, Mass. (28). 1880. B F H

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Bowman, Joseph H., Resident Engineer, Vera Cruz and Pacific Ry., Apartado 21, Cordoba, Mexico. (50). D

Bownocker, Prof. J. A., Ohio State University, Columbus, Ohio. (48). E

*Bowser, Prof. E. A., Rutgers College, New Brunswick, N. J. (28). 1881.

*Boyd, James E., Ohio State Univ., Columbus, Ohio. (46). 1899. B D

*Boye, Martin H., M. D., Coopersburg, Pa. (1). 1896. C

*Brace, Prof. D. B., Univ. of Nebraska, Lincoln, Neb. (48). 1900. B

*Bracken, Henry Martyn, M. D., 1010 Fourth St. S.E., Minneapolis, Minn. (51). 1903. K

Brackenridge, George W., San Antonio, Texas, (41). I

Brackett, Byron B., Ph. D., Rutgers College, New Brunswick, N. J. (46). B

*Brackett, Prof. C. F., Princeton University, Princeton, N. J. (19). 1875. B

Brackett, Frank Parkhurst, Professor of Mathematics, Pomona College, Claremont, Cal. (50). A

*Brackett, Richard N., Clemson College, S. C. (37). 1891. C E

*Bradford, Royal B., Commander, U. S. N., Navy Dept., Washington, D. C. (31). 1891. B D

Bradley, Arthur C., Newport, N. H. (43).

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Bradley, Walter Parke, Ph. D., Professor of Chemistry, Wesleyan University, Middletown, Conn. (50). **C**

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*Branner, Prof. John C., Stanford University, Cal. (34). 1886. **E F**

Brasefield, Stanley Eugene, Instructor in Mathematics, Lafayette College, Easton, Pa. (50). **A**

*Brashear, John A., Allegheny, Pa. (33). 1885. **A B D**

Braunnagel, Jules L. A., M. D., P. O. Box 925, San Antonio, Texas. (50). **F**

*Bray, William L., Professor of Botany, Univ. of Texas, Austin, Texas. (49). 1901. **G**

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Brittin, Lewis H., Ansonia, Conn. (52). **H**

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Brooks, Charles Edward, Lake Roland, Md. (52). A

Brooks, Rev. Earle Amos, 161 Laidley St., Charleston, W. Va. (50). F

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Brownell, Silas B., 71 Wall St., New York, N. Y. (36).
Browning, Charles Clifton, M. D., Highland, Cal. (51). **K**
*Browning, Philip Embury, Kent Chemical Laboratory, Yale University, New Haven, Conn. (46). 1903. **C**
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*Bruner, Lawrence, Professor of Entomology, Univ. of Nebraska, Lincoln, Neb. (50). 1901. **F**
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*Brush, Charles F., 1003 Euclid Ave., Cleveland, Ohio. (35). 1886. **B**
*BRUSH, PROF. GEORGE J., Yale Univ., New Haven, Conn. (4). 1874. **C E**
Bryan, Joseph Hammond, 818 17th St., Washington, D. C. (52).
Bryan, Dr. Walter, Instructor in Biology, College of City of New York, 42 East 28th St., New York, N. Y. (52). **F**
*Bryan, Prof. William L., Indiana Univ., Bloomington, Ind. (49). 1900. **H**
Bryant, Miss D. L., 218 Ashe St., Greensboro, N. C. (42.) **E**
Bryant, Henry G., 2013 Walnut St., Philadelphia, Pa. (51). **E**
Bryson, Andrew, C. E., Brylgon Foundry, Reading, Pa. (51).. **D**
Buchanan, James Isaac, Vice-President Pittsburg Trust Co., 6108 Walnut St., Pittsburg, Pa. (51). **I**
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*Buchner, Edward Franklin, Ph. D., Professor of Philosophy and Pedagogy, University of Alabama, University, Ala. (49). 1901. **H**
*Buckhout, W. A., State College, Pa. (20). 1881. **F**
BUCKLEY, ERNEST ROBERTSON, Ph. D., Director Bureau of Geology and Mines and State Geologist of Missouri, Rolla, Mo. (52). **E**

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Budington, Robert A., Mt. Hermon, Mass. (52). **F K**

Buffum, Burt C., Professor of Agriculture, Agricultural College, Laramie, Wyo. (42). **G**

Buist, John Robinson, M. D., City Board of Health, Nashville, Tenn. (50). **K**

Bull, Coates P., Assistant Professor Agr., Univ. of Minnesota, St. Anthony Park, Minn. (52). **D G**

*Bull, Prof. Storm, University of Wisconsin, Madison, Wis. (44). 1897. **D**

Bullard, Warren Gardner, Ph. D., Associate Professor of Mathematics, Syracuse University, Syracuse, N. Y. (50). **A**

Bullene, Mrs. Emma F. Jay, 1431 Court Place, Denver, Colo. (50). **H**

*Bumpus, H. C., Am. Mus. Nat. Hist., New York, N. Y. (49). 1900.

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Bunn, J. F., Attorney at Law, Tiffin, Ohio, (51). **B**

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Burdick, Lewis Dayton, Oxford, N. Y. (52).

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*Burgess, Thomas J. W., M. D., Medical Supt. Protestant Hospital for the Insane, Montreal, Can. (38). 1889. **G**

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Burrell, Rámon Haddock, M. D., Creighton, Neb. (51). **K**

Burroughs, Paul R., Allison, Iowa. (50). **C**

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Burton, Prof. Alfred E., Mass. Inst. Technology, Boston, Mass. (40). **E**

Burton, Standish Barry, Civil and Mining Engineer, Saltillo, Coahuila, Mexico. (51). **D**

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Busch, Frederick Carl, M. D., 145 Allen St., Buffalo, N. Y. (49).
Bush, John C. F., M. D., Wahoo, Neb. (51). **K**
Bushnell, D. I., Jr., Assistant in Archæology, Peabody Museum, Cambridge, Mass. (52). **H**
*Butler, Amos W., Secretary Board of State Charities, Indianapolis, Ind. (30). 1885. **F H**
Butler, Frank Edward, President of Grayson College, Whitewright, Texas. (50). **I**
Butler, Matthew Joseph, Civil Engineer, 877 Dorchester St., Montreal, P. Q., Canada. (51). **D**
Butterfield, Arthur Dexter, Assistant Professor of Mathematics, University of Vermont, Burlington, Vt. (50). **A D**
Butts, Edward Pontany, C. E., Chief Engineer, Am. Writing Paper Co., Holyoke, Mass. (51). **D**
Byrnes, Owen, Mining Engineer, P. O. Box 131, Marysville, Montana. (51). **D E**
Cabot, Samuel, Manufacturing Chemist, 70 Kilby St., Boston, Mass. (50). **C**
Cady, Walter G., Ph. D., Wesleyan Univ., Middletown, Conn. (49). **B**
*Cain, William, Professor of Mathematics, University of North Carolina, Chapel Hill, N. C. (50). 1901. **A D**
*Cajori, Florian, Professor of Mathematics, Colorado College, Colorado Springs, Colo. (50). 1901. **A**
Calder, George, 105 East 22d St., New York, N. Y. (50).
*Caldwell, Prof. George C., Cornell University, Ithaca, N. Y. (23) 1875. **C**
*Caldwell, Prof. Otis W., State Normal School, Charleston, Ill. (49). 1902. **G**
*Calkins, Gary N., Columbia University, New York, N. Y. (49). 1901. **F**
Calkins, Marshall, M. D., 14 Maple St., Springfield, Mass. (29).
*Calvert, Philip P., Ph. D., Instructor in Zoology, Biological Hall, University of Pennsylvania, Philadelphia, Pa. (50). 1903. **F**
Calvert, Prof. Sidney, Univ. of Missouri, Columbia, Mo. (47). **C**
*Calvin, Prof. Samuel, Dir. Iowa Geol. Surv., Iowa City, Iowa. (37). 1889. **E F**
Camc, Virgil M., 315 Quincy Building, Denver, Colo. (50). **E**
*Cameron, Frank K., Ph. D., Chemist, Bureau of Soils, U. S. Dept. Agriculture, Washington, D. C. (49). 1901. **C**
Cammann, Hermann H., 51 Liberty St., New York, N. Y. (49).
*Campbell, Douglas H., Professor of Botany, Stanford University, Cal. (34). 1888. **G**
Campbell, Henry Donald, Professor Geology and Biology, Washington and Lee University, Lexington, Va. (52). **E F G**

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Campbell, Leslie Lyle, Ph. D., Westminster College, Fulton, Mo. (48).

Campbell, Marius Robison, U. S. Geological Survey, Washington, D. C. (52). **E**

*Campbell, William Wallace, Director of Lick Observatory, Mt. Hamilton, Cal. (50). 1901. **A**

*Canby, William M., 1101 Delaware Avenue, Wilmington, Del. (17). 1878. **G**

*Cannon, George Lyman, Instructor in Geology, Denver High School (No. 1), Denver, Colo. (39). 1901. **E**

Card, Fred. W., Professor of Horticulture, R. I. Coll. Agr. and Mech. Arts, Kingston, R. I. (45). **G**

Carey, Everett P., College City, Cal. (50). **B C**

Cargill, Geo. W., Attorney at Law, Charleston, W. Va. (51). **B D F G**

*Carhart, Prof. Henry S., Univ. of Michigan, Ann Arbor, Mich. (29). 1881. **B**

*Carleton, M. A., U. S. Dept. Agriculture, Washington, D. C. (42). 1894. **G**

Carlson, Anton Julius, Ph. D., Stanford University, Cal. (52). **K**

Carnaghan, Edwin Dixon, Mechanical Engineer, Villa Corona, Mexico. (50). **D**

Carnahan, Charles T., Mining Engineer, Equitable Building, Denver, Colo. (50). **D E**

Carnegie, Thomas Morrison, Trustee of Carnegie Institute, Dungeness, Fernandina, Fla. (50). **F**

Carpenter, Ford A., U. S. Weather Bureau, San Diego, Cal. (44). **B**

Carpenter, Franklin R., Ph. D., Mining Expert, 1420 Josephine St. Denver, Colo. (50). **D E**

*Carpenter, Louis G., Agric. College, Fort Collins, Colo. (32). 1889. **A B**

Carr, William Kearny, 1413 K St., N.W., Washington, D. C. (52).

Carr, William Phillips, M. D., 1418 L St., N.W., Washington, D. C. (51). **K**

*Carroll, James, M. D., 2147 F St., N.W., Washington, D. C. (50). 1903. **F K**

Carroll, James J., Waco, Texas. (50). **F**

Carrow, Flemming, M. D., University of Michigan, Ann Arbor, Mich. (51). **K**

Carson, Shelby Chadwick, M. D., Greensboro, Ala. (51). **K**

Carss, Miss Elizabeth, Teachers' College, New York, N. Y. (49). **G**

Carter, Henry C., 475 West 143d St., New York, N. Y. (50).

Carter, James, M. D., Rawlins, Wyoming. (50). **E K**

Carter, James C., 277 Lexington Ave., New York, N. Y. (36).

*Carter, James Madison G., M. D., Waukegan, Ill. (39). 1895. **F**

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Carter, John E., Knox and Coulter Sts., Germantown, Pa. (33). B H

Carter, Marion H., 504 West 143d St., New York, N. Y. (49).

Carter, William Harrison, Stone Mountain, Ga. (50). A

*Carus, Paul, Ph. D., Editor Open Court Pub. Co., 324 Dearborn St., Chicago, Ill. (40). 1895. H

Cary, Mrs. Elizabeth M. L., 184 Delaware Ave., Buffalo, N. Y. (45). E

Case, Eckstein, Case School of Applied Science, Cleveland, Ohio. (47).

Case, Ermine Cowles, Prof. of Chemistry and Geology, State Normal School, Milwaukee, Wis. (50). B C E

*Casey, Thomas L., Major of Engineers, U. S. A., P. O. Drawer 71, St. Louis, Mo. (38). 1892. D F

Castle, W. E., Instructor in Zoology, Harvard Univ., Cambridge, Mass. (52). F

Caswell, W. H., M. D., 201 West 55th St., New York, N. Y. (50).

Cathcart, Miss J. R., The Barnard, 71st St. and Central Park, New York, N. Y. (50).

*Catlin, Charles A., 133 Hope St., Providence, R. I. (33). 1895. C

Catt, George William, C. E., President, Atlantic, Gulf and Pacific Co., Park Row Building, New York, N. Y. (51). D

*Cattell, H. W., M. D., 3709 Spruce St., Philadelphia, Pa. (50). 1901. K

*Cattell, Prof. James McKeen, Columbia Univ., New York, N. Y. (44). 1896. B F H I

Cerna, Dr. David, Monclova, Coahuila, Mexico. (51).

Chadbourn, Erlon R., Lewiston, Me. (29).

Chadwick, Leroy S., 1824 Euclid Ave., Cleveland, Ohio. (51).

*Chaillé, Stanford E., M. D., LL.D., Dean of Medical Department, Tulane University, New Orleans, La. (51). 1903. K

*Chamberlain, Charles Joseph, Dept. of Botany, University of Chicago, Chicago, Ill. (50). 1902. G

Chamberlain, Frederic M., U. S. Fish Commission, Washington, D. C. (51). F

Chamberlain, Paul Mellen, Prof. of Mechanical Engineering, Lewis Institute, Chicago, Ill. (51). D

Chamberlin, Rollin Thomas, Hyde Park Hotel, Chicago, Ill. (50). C E

*Chamberlin, T. C., Head of Dept. of Geology, Univ. of Chicago, Chicago, Ill. (21). 1877. B E F H

Chamberlin, W. E., Ph. D., 111 Water St., New York, N. Y. (50).

Chambers, Frank R., 842 Broadway, New York, N. Y. (50).

Chambers, Will Grant, Professor of Psychology and Education, State Normal School, Moorhead, Minn. (52). H

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Chambliss, Charles E., Entomologist, S. C. Exper. Sta., Clemson College, S. C. (51). **F**

Chancellor, Wm. E., Supt. of Schools, 343 Belleville Ave., Bloomfield, N. J. (52).

*Chandler, Prof. C. F., School of Mines, Columbia University, New York, N. Y. (19). 1875. **C**

*Chandler, Charles Henry, Professor of Mathematics, Ripon College, Ripon, Wis. (28). 1883. **A**

Chandler, Clarence Austin, Supt. of the Washburn Shops, Worcester Polytechnic Institute, 12 Westland St., Worcester, Mass. (52). **D**

Chandler, Elwyn Francis, Assistant Professor of Mathematics, University of North Dakota, University, N. Dak. (50). **A B**

Chandler, Richard E., Stillwater, Oklahoma. (46). **B D**

*Chandler, Seth C., 16 Craigie St., Cambridge, Mass. (29). 1882. **A**

Chaney, Prof. Lucian W., Carleton College, Northfield, Minn. (45).

Channing, Walter, M. D., Brookline, Mass. (50). **I K**

*Chanute, O., 413 E. Huron St., Chicago, Ill. (17). 1877. **D I**

Chapman, Robert Hollister, U. S. Geological Survey, Washington, D. C. (52). **E**

Charles, Fred. L., Professor of Biology, State Normal School, De Kalb, Ill. (52). **F G**

Charlton, Orlando Clarke, Professor of Biology and Geology, Kalamazoo College, Kalamazoo, Mich. (51). **E F G**

*Chase, Frederick L., Yale University Observatory, New Haven, Conn. (43). 1896. **A**

Chase, Harry Gray, Assistant Professor of Physics, Tufts College, Mass. (52). **B**

Chase, Ira Carleton, M. D., Fort Worth, Texas. (52).

Chase, John, 414-415 Kittridge Bldg., Denver, Colo. (51). **I**

Chase, R. Stuart, 53 Summer St., Haverhill, Mass. (18). **F**

*Chauvenet, Wm. M., Mining Engineer, 620 Chestnut St., St. Louis, Mo. (50). 1901. **C D**

*Cheesman, T. M., M. D., Garrison-on-Hudson, N. Y. (50) 1901. **K**

Cheney, Mrs. B. P., Sr., Wellesley, Mass. (51).

*Cheney, Lellen Sterling, 318 Bruen St., Madison, Wis. (42). 1894. **G**

Cheney, Newel, Poland Center, N. Y. (52).

Cheney, Willard Colfax, Electrical Engineer, Portland, Oregon. (50). **D**

*Chester, Colby M., Captain, U. S. N., Naval Observatory, Washington, D. C. (28). 1897. **E**

Chester, Wayland Morgan, Associate Professor of Biology, Colgate University, Hamilton, N. Y. (50). **F**

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*Chickering, J. W., The Portner, Washington, D. C. (22). 1877. G I
Chilcott, Ellery Channing, Professor of Geology, Agricultural College, Brookings, S. D. (50). E
*Child, Charles Manning, Instructor in Zoology, University of Chicago, Chicago, Ill. (50). 1901. F
*Child, Clement D., Colgate Univ., Hamilton, N. Y. (44). 1899. B
Childs, Arthur Edward, V.P. and Treas. the Light, Heat and Power Corporation, 23 Central St., Boston, Mass. (50). B D I
Childs, James Edmund, Civil Eng., 300 W. 93d St., New York, N. Y. (51). D
Chisholm, A. Arthur, M. D., Kelseyville, Cal. (51). K
Chisholm, Hugh J., 813 Fifth Avenue, New York, N. Y. (50).
Chisolm, George E., 19 Liberty St., New York, N. Y. (50).
*Chittenden, Frank Hurlbut, U. S. Dept. Agriculture, Washington, D. C. (48). 1901. F
*Chittenden, Russell H., Director of Sheffield Scientific School, Yale University, New Haven, Conn. (50). 1901. C F
Chittenden, Thomas A., Instructor in Mechanical Engineering, A. and M. College, W. Raleigh, N. C. (50). D
*Christie, James, Chief Mech. Engineer Am. Bridge Co., Pencoyd, Pa. (33). 1894. D
Chrystie, Wm. F., Hastings-on-Hudson, N. Y. (36).
Church, E. D., Jr., 63 Wall St., New York, N. Y. (50).
Church, Royal Tyler, Turin, N. Y. (38). D F
Churchill, William, Yale University, New Haven, Conn. (52). H
Churchill, William W., care of Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York, N. Y. (51). D
Churchward, Alexander, 44 Broad St., New York, N. Y. (52).
*Chute, Horatio N., Instructor in Physical Sciences, High School, Ann Arbor, Mich. (34). 1889. A B C
*Cilley, Frank H., Mass. Inst. Technology, Boston, Mass. (49). 1901. A B D
Clancy, Michael Albert, 1426 Corcoran St., Washington, D. C. (40). H
*Clapp, Miss Cornelia M., Mt. Holyoke College, South Hadley, Mass. (31). 1883. F
Clapp, Frederick Gardner, U. S. Geological Survey, Washington, D. C. (51). E
Clark, Alexander S., Westfield, N. J. (33).
Clark, Austin Hobart, 68 Perkins Hall, Cambridge, Mass. (52). F
Clarke, Miss Cora H., 91 Mt. Vernon St., Boston, Mass. (47). F G
Clark, Edmund, 426 Sanford Ave., Flushing, L. I., N. Y. (50).
Clark, Ernest P., 58 Broad St., New York, N. Y. (50). 1901. D
Clark, Friend Ebenezer, Associate Professor of Chemistry, University of West Virginia, Morgantown, W. Va. (51). C

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*Clarke, Prof. F. W., U. S. Geol. Survey, Washington, D. C. (18). 1874. C

*Clark, Gaylord Parsons, Professor of Physiology, Syracuse University, Syracuse, N. Y. (50). 1901. F K

Clark, Herbert A., Haskell Institute, Lawrence, Kansas. (50). B C

Clark, Howard Walton, Field Columbian Museum, Chicago, Ill. (52). F

Clark, Hubert Lyman, Ph. D., Professor of Biology, Olivet College, Olivet, Mich. (50). F

Clark, James Albert, "The Cumberland," Washington, D. C. (52).

Clark, James Frederick, M. D., Fairfield, Iowa. (50). I K

*Clark, Prof. John E., 34 S. Park Terrace, Long Meadow, Mass. (17).

Clark, John Jesse, Dean of Faculty, International Correspondence Schools, Scranton, Pa. (50). B D

*Clarke, John Mason, Ph. D., Asst. State Geologist and Palæontologist, State Hall, Albany, N. Y. (45). 1897. E

*Clark, John S., 110 Boylston St., Boston, Mass. (31). 1901. B C I

Clark, Judson F., Assistant Professor of Forestry, New York College of Forestry, Ithaca, N. Y. (52).

Clark, Miss May, Instructor in Physics, The Woman's College, Baltimore, Md. (52). B

Clark, Oliver Durfee, 590 Halsey St., Brooklyn, N. Y. (41). E F

*Clarke, Prof. Samuel Fessenden, Williams College, Williamstown, Mass. (50). 1901. F

Clark, Thomas H., Box 166, Plymouth, N. H. (40).

Clark, W. A., Ph. D., President State Normal School, Peru, Neb. (52).

Clark, Wm. Brewster, M. D., 50 E. 31st St., New York, N. Y. (33). C F

*Clark, Wm. Bullock, Ph. D., Johns Hopkins University, Baltimore, Md. (37). 1891. E

Claudy, C. H., 1302 F St., N.W., Washington, D. C. (52). A B C

Claxton, P. P., Univ. of Tennessee, Knoxville, Tenn. (52).

*Claypole, Miss Agnes M., Pasadena, Cal. (46). 1899. F

*Claypole, Miss Edith J., Pasadena, Cal. (46). 1899. F

Cleaver, Albert N., South Bethlehem, Pa. (50). D

Cleburne, William, 1219 So. Sixth St., Omaha, Neb. (51). G

Clements, Frederic Edward, Ph. D., Associate Professor of Botany, Univ. of Nebraska, Lincoln, Neb. (52).

Clements, Joseph, M. D., Nutley, N. J. (52). K

*Clements, Julius Morgan, Assistant Professor of Geology, University of Wisconsin, Madison, Wis. (51). 1903. E

Clerc, Frank L., Hotel Metropole, Denver, Colo. (50). C D

Clifton, Richard S., Assistant Secretary, A. A. A. S., Washington, D. C. (49). F

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Cline, Isaac M., M. D., U. S. Weather Bureau, New Orleans. La. (50). K

*Cloud, John W., 974 Rookery, Chicago, Ill. (28). 1886. A B D

Clough, Albert L., Box 114, Manchester, N. H. (45). B

Coates, Charles E., Ph. D., Louisiana State Univ., Baton Rouge, La. (46). C

Cobb, Arthur, Architect, 600 Equitable Building, Louisville, Ky. (50). D

Cobb, Prof. Collier, University of North Carolina, Chapel Hill, N. C. (49).

*Cochran, C. B., 514 South High St., West Chester, Pa. (43). 1896. C

*Cockerell, T. D. A., East Las Vegas, New Mexico. (50). 1901. F

Cockran, Hon. W. Bourke, 31 Nassau St., New York, N. Y. (50).

Coe, Henry W., M. D., "The Marquam," Portland, Oregon. (32). F H

Coe, Thomas Upham, M. D., Bangor, Maine. (51). K

Coffeen, Hon. H. A., Sheridan, Wyoming. (51).

Coffin, C. A., 44 Broad St., New York, N. Y. (50).

*Coffin, Selden J., Ph. D., Lafayette College, Easton, Pa. (22). 1874. A I

Coghill, George Ellett, Ph. D., Professor of Biology, Pacific Univ., Forest Grove, Oregon. (52). F G

*Cogswell, Wm. B., Syracuse, N. Y. (33). 1891. D

Cohen, Mendes, Civil Engineer, 825 N. Charles St., Baltimore, Md. (50). D

*Cohen, Solomon Solis, M. D., 1525 Walnut St., Philadelphia, Pa. (50). 1903. F K

Coit, Joseph Howland, Saint Paul's School, Concord, N. H. (50).

Coit, J. Milner, Ph. D., Saint Paul's School, Concord, N. H. (33). B C E

Coker, Wm. Chambers, Ph. D., Associate Professor of Botany, Univ. of North Carolina, Chapel Hill, N. C. (52). G

*Colburn, Richard T., Elizabeth, N. J. (31). 1894. F H I

Colby, Edward A., care Baker Platinum Works, Newark, N. J. (49).

*Cole, Prof. Alfred D., Ohio State Univ., Columbus, Ohio. (39). 1891. B C

Cole, George Watson, Graham Court, 1925 Seventh Ave., New York, N. Y. (52).

Cole, Leon Jacob, 41 Wendell St., Cambridge, Mass. (52). F

Cole, W. F., M. D., Waco, Texas. (51). K

Coleman, Clarence, U. S. Assistant Engineer, Duluth, Minn. (51). D H

Coleman, Walter, Prof. of Natural History, Sam Houston Normal Institute, Huntsville, Texas. (51). K

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Colgate, Abner W., Morristown, N. J. (44).
Colie, Edw. M., East Orange, N. J. (30). **E I**
Collett, Samuel Williamson, Principal of High School, Urbana, Ohio. (50). **G**
Collier, Arthur James, U. S. Geological Survey, Washington, D. C. (52). **E**
Collier, Price, Tuxedo Park, N. Y. (50).
*Collin, Prof. Alonzo, Cornell College, Mount Vernon, Iowa. (21). 1891. **B C**
Collin, Rev. Henry P., 58 Division St., Coldwater, Mich. (37). **H**
*Collingwood, Francis, Elizabeth, N. J. (36). 1888. **D**
Collins, Guy N., 2818 13th St. N.W., Washington, D. C. (51). **G**
Collins, T. Shields, M. D., Globe, Arizona. (51). **K**
Colton, Geo. H., Professor of Natural Science, Hiram College, Hiram, Ohio. (51). **B E**
*Colvin, Verplanck, Supt. N. Y. State Adirondack Survey, Albany, N. Y. (28). 1880. **E**
*Comstock, Prof. Charles Worthington, Civil and Mining Engineer, 76 Grant Ave., Denver, Colo. (47). 1901. **A D**
*Comstock, Prof. Geo. C., Washburn Observatory, University of Wisconsin, Madison, Wis. (34). 1887. **A**
*Comstock, Prof. Theo. B., Mining and Metallurgical Engineer, 534 Stinson Bldg., Los Angeles, Cal. (24). 1877. **B D E**
Comstock, Dr. T. Griswold, 3401 Washington Ave., St. Louis, Mo. (29). **F H**
Conant, Charles A., Treasurer Morton Trust Co., 38 Nassau St., New York, N. Y. (52). **I**
Conant, Miss E. Ida, 42 W. 48th St., New York, N. Y. (33). **F H I**
*Conant, Prof. Levi L., Polytechnic Institute, Worcester, Mass. (39). 1892. **A**
Conarroe, Thomas H., M. D., Lecturer on Biology, Hahnemann Medical College of Philadelphia, Philadelphia, Pa. (50). **F K**
*Conklin, Edwin Grant, Professor of Biology, University of Pennsylvania, Philadelphia, Pa. (50). 1901. **F**
Connaway, J. W., Professor Veterinary Science, Missouri State Univ., Columbia, Mo. (52). **F**
Connelley, C. B., Supervisor Industrial Schools, Allegheny, Pa. (49). **I**
Connor, Leartus, M. D., President of Michigan State Medical Society, 103 Cass St., Detroit, Mich. (51). **K**
Conradson, Pontus H., Chief Chemist, Galena-Signal Oil Co., Franklin, Pa. (51). **B C D**
Constant, Frank H., Professor of Structural Engineering, University of Minnesota, Minneapolis, Minn. (51). **D.**
Converse, Vernon G., 15th St. and Liberty Ave., Pittsburg, Pa. (50). **D**

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Conway, George M., Mechanical Engineer, 10 Belvedere, Milwaukee, Wis. (51). **D**

Cook, Dr. Charles D., 162 Remsen St., Brooklyn, N. Y. (25).

Cooke, George Willis, Park St., Wakefield Park, Wakefield, Mass. (47). **H I**

Cook, James B., Randolph Building, Memphis, Tenn. (50).

*Cook, Melville T., De Pauw University, Greencastle, Ind. (45). 1902. **G**

*Cook, Orator F., U. S. Dept. of Agriculture, Washington, D. C. (40). 1892. **G**

*Cook, Samuel R., Case School, Cleveland, Ohio. (50). 1903. **B C**

*Cooley, Grace E., Ph. D., Wellesley College, Wellesley, Mass. (47). 1900. **G I**

*Cooley, Prof. LeRoy C., Vassar College, Poughkeepsie, N. Y. (19). 1880. **B C**

*Cooley, Prof. Mortimer E., University of Michigan, Ann Arbor, Mich. (33). 1885. **D**

Cooley, Robert A., Zoologist and Entomologist, Montana Agr'l College and Experiment Station, Bozeman, Montana. (50). **F**

Cooper, Hon. Edward, 12 Washington Square, N., New York, N. Y. (49).

Cooper, Hermon Charles, Ph. D., Instructor in Chemistry, Syracuse University, Syracuse, N. Y. (51). **C**

Cooper, James Campbell, Room 5, Veale Block, Topeka, Kansas. (50). **C E**

*Copeland, Edwin Bingham, 653 E. 57th St., Chicago, Ill. (45). 1901. **G**

*Coplin, W. M. L., M. D., Professor of Pathology and Bacteriology, Jefferson Medical College, Philadelphia, Pa. (51). 1903. **K**

*Coquillett, Daniel William, U. S. National Museum, Washington, D. C. (43). 1902. **F**

*Corbett, L. C., U. S. Dept. Agriculture, Washington, D. C. (48). 1901. **G**

Cornelison, Robert W., Sc.D., Manufacturing Chemist, Bloomfield, N. J. (51). **C**

Cornish, George A., Lindsay, Ont., Canada. (52). **F**

Cornman, Oliver P., Ph. D., 2252 N. 20th St., Philadelphia, Pa. (46). **H**

*Corthell, Elmer L., 1 Nassau St., New York, N. Y. (34). 1886. **D E I**

Corwin, Clifford Egbert, Teacher of Science, Marietta High School Marietta, Ohio. (50). **C**

Coster, William H., Chemist and Biologist to Bureau of Water, Department of Public Works, Pittsburg, Pa. (51). **C**

*Coulter, Prof. John M., University of Chicago, Chicago, Ill., (32). 1884. **G**

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Coulter, Samuel Monds, The Shaw School of Botany, St. Louis, Mo. (52). **G**

Courtis, William Munroe, 412 Hammond Bldg., Detroit, Mich. (46). **E C G**

Coutant, Richard Bonnet, M. D., Tarrytown, N. Y. (51). **K**

*Coville, Frederick V., U. S. Dept. Agriculture, Washington, D. C. (35). 1890. **G**

*Cowles, Alfred H., 656 Prospect St., Cleveland, Ohio. (37). 1897. **B C**

*Cowles, Edward, M. D., Medical Supt. McLean Hospital, Waverly, Mass. (51). 1903. **K**

Cowles, Miss Louise F., Mt. Holyoke College, South Hadley, Mass. (47). **E**

Cox, Abraham Beekman, Civil Engineer, Cherry Valley, N. Y. (50). **D**

*Cox, Charles F., Grand Central Depot, New York, N. Y. (43). 1900. **F G**

Cox, Edmund Otis, C. E., Manhattan Railway Co., 1878 Seventh Ave., New York, N. Y. (51). **D**

Cox, John, Professor of Experimental Physics, McGill University. Montreal, Can. (51). **B**

Cox, Ulysses O., Professor of Biology, State Normal School, Mankota, Minn. (50). **F**

Coxe, Eckley B., Jr., U. S. Weather Bureau Observer, Drifton, Pa, (51).

Coyle, Rev. John S., S. J., St. Joseph's College, 17th and Stiles Sts., Philadelphia, Pa. (48). **B**

*Crafts, James Mason, Mass. Inst. Technology, Boston, Mass. (47). 1898. **C**

*Cragin, Francis Whittemore, Ph. D., 1715 Wood Ave., Colorado Springs, Colo. (29). 1890. **E F H**

Craig, Alexander Righter, M. D., 232 Cherry Street, Columbia, Pa. (51). **K**

Craig, John, College of Agriculture, Cornell University, Ithaca, N. Y. (41). **G**

Craig, Wallace, Zoological Laboratory, Univ. of Chicago, Chicago, Ill. (50). **F**

CRAM, ROYS JONES, 26 Hancock Ave., West, Detroit, Mich. (51).

*Crampton, Chas. A., M. D., Office of Internal Revenue Commissioner, U. S. Treasury Dept., Washington, D. C. (36). 1887. **C**

*Crampton, Henry E., Adjunct Professor of Zoology, Barnard College, Columbia University, New York, N. Y. (51). 1903. **F**

*Crandall, Charles S., 1108 Oregon St., Urbana, Ill. (40). 1894.

Crandall, Francis Asbury, Librarian of Public Documents, 2219 15th St., N.W.. Washington, D. C. (50). **I**

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Crane, James M., Board of Education, Newburgh, N. Y. (50). I
Crane, Walter, Supt. Carnegie Free Library, Braddock, Pa. (47). G
Cranford, J. P., Wakefield, New York, N. Y. (50).
Cranston, Robert E., E. M., Fair Oaks, Cal. (50). D E
Cratty, R. I., Armstrong, Iowa. (52). G
Crawford, David Francis, Supt. Motive Power, Penna. Co., Ft. Wayne, Ind. (50). D
Crawford, John, Leon, Nicaragua, Central America. (40). E H
*Crawford, Morris B., Middletown, Conn. (30). 1889. B
*Crawley, Edwin S., Ph. D., University of Pennsylvania, Philadelphia, Pa. (45). 1900. A
Crawley, Howard, Wyncote, Pa. (51). F
Crehore, Albert Cushing, 48 Lincoln Terrace, Yonkers, N. Y. (50). D E
Crew, Henry, Professor of Physics, Northwestern University, Evanston, Ill. (52). B
*Crile, George W., M. D., 169 Kensington St., Cleveland, Ohio. (51). 1903. K
Crockard, Frank Hearne, E. M., C. E., Asst. Mgr. Riverside Dept. National Tube Co., Lock Box 34, Wheeling, W. Va. (50). D
*Crocker, Francis B., Professor of Electrical Engineering, Columbia University, New York, N. Y. (50). 1901. B D
*Crockett, Prof. Charles W., Rensselaer Polytechnic Institute, Troy, N. Y. (39). 1894. A D
Crook, Alja Robinson, Ph. D., 1914 Sheridan Road, Evanston, Ill. (47). E
Crosby, Oscar Terry, Cosmos Club, Washington, D. C. (52). C E I
Crosby, William Edward, 1603 Amsterdam Ave., New York, N. Y. (52).
*Crosby, Prof. W. O., Mass. Institute Technology, Boston, Mass. (47). 1900. E
*Cross, Prof. Charles R., Mass. Inst. Technology, Boston, Mass. (29). 1880. B
Crouse, Hugh Woodward, M. D., Victoria, Texas. (50). F K
CROWELL, A. F., Woods Holl, Mass. (30). C
*Crowell, John Franklin, Bur. of Statistics, Treasury Dept., Washington, D. C. (50). 1901. I
Crozier, William, Brigadier-General and Chief of Ordnance, U. S. A., War Department, Washington, D. C. (50). D
Crump, Col. M. H., Bowling Green, Ky. (29). E
Crunden, Frederick Morgan, Librarian Public Library, 3635 Laclede Ave., St. Louis, Mo (52). I
Cryer, Matthew H., M. D., D. D. S., 1420 Chestnut St., Philadelphia, Pa. (50). F K
*Culin, Stewart, Univ. of Pennsylvania, Philadelphia, Pa. (33). 1890. H

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*Cumings, Edgar R., Bloomington, Ind. (48). 1901. **E**

*Cummings, Miss Clara E., Wellesley College, Wellesley, Mass. (47). 1899. **G**

Cummins, George Wyckoff, M. D., Belvidere, N. J. (50). **G K**

Cunningham, Francis A., 1613 Wallace St., Philadelphia, Pa. (33). **B D E**

*Cunningham, Prof. Susan J., Swarthmore College, Swarthmore, Pa. (38). 1901. **A**

Curran, Ulysses T., Probate Judge, Erie Co., Sandusky, Ohio. (52). **I**

Currie, C. A., M. D., P. O. Box 1606, Philadelphia, Pa. (48). **F**

*Curtis, Carlton C., Columbia University, New York, N. Y. (51). 1903. **G**

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Curtis, Geo. W., McKinney, Texas. (50).

Curtis, H. Holbrook, M. D., 118 Madison Ave., New York, N. Y. (51). **K**

Curtis, Mattoon M., Prof. of Philosophy, Western Reserve University, Cleveland, Ohio. (50). **H I**

Curtiss, Richard Sydney, Asst. Prof. of Chemistry, Union College, Schenectady, N. Y. (52). **C**

*Curtis, William E., Post Building, Washington, D. C. (40). 1903. **H I**

Cushing, Harvey, M. D., 3 West Franklin St., Baltimore, Md. (52). **K**

*Cushing, Henry Platt, Adelbert College, Cleveland, Ohio. (33). 1888. **E**

Cushing, John J., 1001 Union Trust Bldg., Cincinnati, Ohio. (50). **D**

*Cushman, Allerton, Ph. D., Bureau of Chemistry, U. S. Dept. Agriculture, Washington, D. C. (50). 1901. **C**

*Cushny, Arthur R., Professor of Materia Medica and Therapeutics, Univ. of Michigan, Ann Arbor, Mich. (50). 1901. **K**

Cutler, Colman Ward, M. D., 36 East 33d St., New York, N. Y. (50). **K**

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Cutter, Irving S., Box 732, Lincoln, Neb. (50). **F G**

Cutter, W. D., College of Physicians and Surgeons, Columbia Univ., New York, N. Y. (50). **K**

*Dabney, Charles W., Ph. D., President University of Tennessee, Knoxville, Tenn. (47). 1901. **C**

Daggette, Alvin S., M. D., 400 South Craig St., Pittsburg, Pa. (50). **F K**

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*Dall, William Healey, Smithsonian Institution, Washington, D. C. (18). 1874. F H

Dalrymple, W. H., Prof. Vet. Science, La. State Univ. and A. & M. College, Baton Rouge, La. (50). F K

*Dana, Dr. Charles L., 50 W. 46th St., New York, N. Y. (46). 1889. H

*Dana, Edward Salisbury, New Haven, Conn. (23). 1875. B E

Daniel, John, Professor of Physics, Vanderbilt Univ., Nashville, Tenn. (50). B

Danielson, A. H., Agricultural College, Fort Collins, Colo. (50). G

*Darton, Nelson H., U. S. Geol. Survey, Washington, D. C. (37). 1893.

Daugherty, Rev. Jerome, S. J., President of Georgetown Univ., Washington, D. C. (52).

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Davenport, Eugene, Dean of the College of Agriculture, University of Illinois, Champaign, Ill. (39).

Davenport, Francis Henry, M. D., 419 Boylston St., Boston, Mass. (50). K

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Davidson, R. J., Agric. Exper. Station, Blacksburg, Va. (40). C

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Davis, Abial B., 129 East Lincoln Ave., Mt. Vernon, N. Y. (44). A

Davis, Andrew McFarland, 10 Appleton St., Cambridge, Mass. (35). H

Davis, Bergen, Columbia University, New York, N. Y. (49). B

*Davis, Bradley Moore, Dept. of Botany, Univ. of Chicago, Chicago, Ill. (45). 1897. G

Davis, Charles F., Fort Collins, Colo. (50). C

Davis, Charles Gilbert, M. D., 31 Washington St., Chicago, Ill. (51). K

*Davis, C. H., Commander U. S. N., Navy Dept., Washington, D. C. (40). 1896.

Davis, Edward E., 47 W. Main St., Norwich, N. Y. (50).

Davis, George S., P. O. Box 724, Detroit, Mich. (50).

*Davis, Herman S., Ph. D., Director of International Latitude Station, Gaithersburg, Md. (50). 1901. A

*Davis, J. J., M. D., 1119 College Ave., Racine, Wis. (31). 1899. F G

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Davis, N. S., Jr., 291 Huron St., Chicago, Ill. (50). F G
*Davis, Wm. Harper, Asst. in Psychology, Columbia Univ., New York, N. Y. (50). 1903. H I
*Davis, Prof. Wm. Morris, Cambridge, Mass. (33). 1885. B E
Davis, Wm. Walley, Virginia Iron, Coal and Coke Co., Roanoke, Va. (50). C
Davison, Alvin, Ph. D., Lafayette College, Easton, Pa. (49).
Davison, Lt. Gregory C., U. S. N., care Navy Department, Washington, D. C. (52). D
Davison, John M., 340 Oxford St., Rochester, N. Y. (38). C
Daviss, Edward Paxton, M. D., 205–6 Binz Building, Houston, Texas, (51). K
*Davy, Joseph Burtt, State Agrostologist and Botanist, Department of Agriculture, Pretoria, Transvaal. (51). 1903. G
Dawson, Percy Millard, M. D., Instructor in Physiology, Johns. Hopkins Medical School, Baltimore, Md. (50). K
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*Day, William Scofield, Ph. D., Tutor in Physics, Columbia University, New York, N. Y. (50). 1901. B
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Dean, Seth, C. E., Surveyor of Mills County, Glenwood, Iowa. (34). D
Dean, Wm. H., 167 West River St., Wilkes-Barre, Pa. (50). C
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Dearborn, George Van Ness, Ph. D., Professor of Physiology, Tufts Medical and Dental Schools, Boston, Mass. (52). K
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de Forest, Robert W., 30 Broad St., New York, N. Y. (49).
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Delano, Frederic A., Supt. of Motive Power, C. B. and Q. Railroad, 209 Adams St., Chicago, Ill. (50). **D**

Delany, Patrick Bernard, E. E., Inventor, South Orange, N. J. (50). **D**

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Dennett, William S., 8 East 49th St., New York, N. Y. (52). **A K**

*Dennis, David Worth, Professor of Biology, Earlham College, Richmond, Ind. (50). 1901. **F**

*Dennis, Louis Munroe, Cornell University, Ithaca, N. Y. (43). 1895. **C**

de Peyster, Johnston Livingston, Tivoli, New York. (52).

de Raasloff, Harold, Civil Engineer, 18 Burling Slip, New York, N. Y. (51). **D**

Derby, George McClellan, Major, Corps of Engineers, U. S. A., Louisville, Ky. (50). **D**

*Derby, Orville A., Commissao Geologica, Sao Paulo, Brazil, South America. (39). 1890. **E**

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Detmers, Fredericka, 1315 Neil Ave., Columbus, Ohio. (48). **G**

Devereux, W. B., 99 John St., New York, N. Y. (50).

*Dewey, Lyster H., U. S. Dept. Agriculture, Washington, D. C. (40). 1899. **F G**

Dexter, E. G., Ph. D., Professor of Education and Psychology, University of Illinois, Urbana, Ill. (52). **K**

*Dexter, Franklin, M. D., Associate Professor of Anatomy, Harvard Medical School, Boston, Mass. (50). 1901. **K**

Dickerson, E. N., 141 Broadway, New York, N. Y. (49).

Dickinson, Gordon K., M. D., 278 Montgomery St., Jersey City, N. J. (51). **K**

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Diemer, Hugo, Associate Professor of Mechanical Engineering, Univ. of Kansas, Lawrence, Kans. (49).

*Diller, J. S., U. S. Geological Survey, Washington, D. C. (52). 1903. E

*Dimmock, George, Box 1597, Springfield, Mass. (22). 1874. F

Dimock, Mrs. Henry F., 25 East 60th St., New York, N. Y. (50).

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Dixon, Brandt B., President of Newcomb College, New Orleans, La. (52). K

*Dixon, Roland B., Peabody Museum, Cambridge, Mass. (46). 1901. H

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Dixson, Prof. Zella Allen, Librarian University of Chicago, Chicago, Ill. (52). I

*Dock, George, M. D., 1014 Cornwell Place, Ann Arbor, Mich. (51). 1903. K

*Dodge, Charles Richards, 1336 Vermont Ave., N.W., Washington, D. C. (22). 1874.

*Dodge, Charles Wright, Univ. of Rochester, Rochester, N. Y. (39). 1898. F

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*Dodge, Richard E., Teachers' College, Columbia Univ., New York, N. Y. (49). 1901. E I

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Doherty, Manning William, Associate Professor of Biology, Ontario Agricultural College, Guelph, Canada. (50). F G

*Dolbear, Prof. A. Emerson, Tufts College, Mass. (20). 1880. B

Dole, Rev. Charles Fletcher, Jamaica Plain, Mass. (50). I

Domenech, Manuel V., Civil Engineer and Architect, Lock Box 220, Ponce, Porto Rico. (50). D I

Donovan, Cornelius, Assistant Engineer, U. S. Engineer Office, Custom House, New Orleans, La. (51). D

*Doolittle, Prof. C. L., Upper Darby, Pa. (25). 1885. A

*Dorsey, George A., Ph. D., Field Columbian Museum, Chicago, Ill. (39). 1892. H

Dorsey, Herbert Grove, Professor of Physics, Fla. Agr. College, Lake City, Fla. (51). B

*Dorsey, N. Ernest, Ph. D., Annapolis Junction, Md. (46). 1898. B

Doty, Paul, 230 Woodward Ave., Detroit, Mich. (43). D

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Doughty, Mrs. Alla, Milford, Pa. (49).
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Douglas, James, 99 John St., New York, N. Y. (49).
Douglas, Orlando B., 20 Pleasant St., Concord, N. H. (49).
*Douglass, Andrew E., Amer. Mus. of Nat. History, Central Park, New York, N. Y. (31). 1885. **H**
Dow, Allan Wade, District Bldg., Washington, D. C. (52). **C D**
Dow, Herbert H., Midland, Mich. (47). **C**
Dowell, Philip, Ph. D., High School, Port Richmond, N. Y. (50). **F**
Downing, Elliott Rowland, Ph. D., Professor of Biology, Northern State Normal School, Marquette, Mich. (51). **F**
Downs, Edgar Selah, Thurston Preparatory School, Shady Ave., Pittsburg, Pa. (50). **B**
Downs, Norton, M. D., 215 West Walnut Lane, Germantown, Philadelphia, Pa. (52). **K**
*DRAPER, DANIEL, Ph. D., N. Y. Meteorological Observatory, Central Park, 64th St., Fifth Ave., New York, N. Y. (29). 1881. **A B D F**
Draper, Mrs. Henry, 271 Madison Ave., New York, N. Y. (49).
Drayer, H. C., Manual Training School, Washington University, St. Louis, Mo. (51).
Drescher, Willibald A. E., P. O. Drawer 1033, Rochester, N. Y. (41). **F**
Dreyfus, Dr. William, 162 East 95th St., New York, N. Y. (52). **C**
Droop, Edward F., 1455 Bacon St., Washington, D. C. (52). **I**
*DROPPERS, GARRETT, President of the State University, Vermillion, S. Dak. (50). 1901. **I**
*Drown, Prof. Thos. M., Lehigh University, South Bethlehem, Pa. (29). 1881. **C**
Drummond, Isaac Wyman, Ph. D., 436 W. 22d St., New York, N. Y. (36).
*Dryer, Charles Redway, Professor of Geography, Indiana State Normal School, Terre Haute, Ind. (50). 1903. **E**
Duane, Russell, 911 Pine St., Philadelphia, Pa. (50). **I**
*Duane, William, Ph. D., Professor of Physics, State University, Boulder, Colo. (50). 1901. **B**
*DU BOIS, PROF. AUG. J., New Haven, Conn. (30). 1882. **A B D**
Du Bois, Howard Weidner, 4526 Regent St., Philadelphia, Pa. (47). **A**
*Du Bois, Patterson, 401 So. 40th St., Philadelphia, Pa. (33). 1887. **C H I**
DuBois, Wm. E. B., Professor of Economics and History, Atlanta University, Atlanta, Ga. (50). **I**

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Dudgeon, H. R., M. D., Demonstrator of Surgery, School of Medicine, University of Texas, Galveston, Texas. (50). **F K**

*Dudley, Charles B., Drawer 156, Altoona, Pa. (23). 1882. **B C D**

Dudley, S. W., 333 York St., New Haven, Conn. (50). **A D**

*Dudley, Wm. L., Vanderbilt University, Nashville, Tenn. (28). 1881. **C**

*Dudley, Prof. Wm. R., Dept. of Systematic Botany, Stanford University, Cal. (29). 1883. **G**

Duerden, J. E., Ph. D., Professor of Biology, University of North Carolina, Chapel Hill, N. C. (52). **F**

*Duggar, Benjamin Minge, Professor of Botany, Univ. of Missouri, Columbia, Mo. (45). 1900. **G**

Duke, Frank Williamson, Professor of Mathematics, Hollins Institute, Hollins, Va. (50). **A**

Dulles, Charles W., M. D., 4101 Walnut St., Philadelphia, Pa. (51). **K**

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*Dumble, E. T., Consulting Geologist, Southern Pacific Co., 1708 Prairie Ave., Houston, Tex. (37). 1891. **E**

Duncan, Fred. N., Professor of Biology, Emory College, Oxford, Ga. (50). **C**

*Duncan, George Martin, Professor of Philosophy, Yale University, New Haven, Conn. (50). 1902. **H**

Duncanson, Henry Bruce, Professor of Biology, State Normal School, Peru, Neb. (50). **F**

Duncklee, John B., Civil Engineer, 35 Fairview Ave., South Orange, N. J. (51). **D**

*Dunham, Edward K., M. D., Professor of Pathology, Carnegie Laboratory, 338 East 26th St., New York, N. Y. (30). 1890.

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Dunham, Kennon, M. D., Auburn Ave. and McMillan St., Cincinnati, Ohio. (51). **K**

Dunlevy, Robert Baldwin, Prof. Kansas State Normal College, Winfield, Kansas. (50). **C E**

Dunn, Gano Sillick, Electrical Engineer, Crocker-Wheeler Company, Ampere, N. J. (50). **D**

Dunn, Ira J., M. D., 810 Peach St., Erie, Pa. (51). **K**

Dunning, Lehman H., M. D., 224 N. Meridian St., Indianapolis, Ind. (51). **K**

*Dunnington, Prof. F. P., University Station, Charlottesville, Va. (26). 1880. **C**

*Dunstan, A. St. C., Professor of Electrical Engineering, Polytechnic Institute, Auburn, Ala. (50). 1901. **B D**

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*Durand, W. F., Ph. D., Cornell University, Ithaca, N. Y. (37). 1890. **B**

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Duval, Edmund P. R., 32 Irving St., Cambridge, Mass. (50).

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Duvel, Joseph W. T., 2818 13th St., N.W., Washington, D. C. (48). **G**

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*Dwight, Prof. William B., Vassar College, Poughkeepsie, N. Y. (30). 1882. **E F**

*Dyar, Harrison G., Ph. D., U. S. National Museum, Washington, D. C. (43). 1898.

Dyche, Lewis Lindsay, Professor of Systematic Zoology and Taxidermist, University of Kansas, Lawrence, Kans. (51). **F**

Dysterud, E., Electrical Engineer, Monterey, Mexico. (50). **D**

Eagleson, James B., M. D., 512 Burke Bldg., Seattle, Wash. (51). **K**

*Earle, F. S., N. Y. Botanical Garden, Bronx Park, New York. (39). 1896. **G**

Earll, Charles Isaac, M. E., 76 William St., New York, N. Y. (52). **D**

*Eastman, Charles Rochester, Museum Comp. Zoology, Cambridge, Mass. (41). 1896. **E F**

*Eastman, Prof. J. R., Andover, N. H. (26). 1879. **A**

*Eastwood, Miss Alice, Curator of Herbarium, California Academy of Sciences, San Francisco, Cal. (50). 1901. **G**

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Eccles, David Charles, Northwestern Univ., Evanston, Ill. (50). **C**

*Eccles, Robert G., M. D., 191 Dean St., Brooklyn, N. Y. (31). 1894. **C F**

Eckel, Edwin C., Assistant Geologist, U. S. Geological Survey, Washington, D. C. (51). **E**

Eckles, C. H., Columbia, Mo. (50). **F**

*Eddy, Prof. H. T., Univ. of Minnesota, Minneapolis, Minn. (24). 1875. **A B D**

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Edmonds, Richard H., President and Editor, "Manufacturers' Record," Baltimore, Md. (50). **D**

Edwards, Arthur M., M. D., F. L. S., F. R. M. S., R. A. S., 333 Belleville Ave., Newark, N. J. (52). **K**

*Edwards, Prof. Charles Lincoln, Trinity College, Hartford, Conn. (49). 1900. **F**

Edwards, Col. Clarence R., U. S. A., Chief of the Bureau of Insular Affairs, War Department, Washington, D. C. (52). **I**

Edwards, Prof. John W., Iowa Wesleyan University, Mt. Pleasant Iowa. (48).

Ehrenfeld, Frederick, Ph. D., Instructor in Geology, University of Pennsylvania, Philadelphia, Pa. (50). **E**

Ehrhorn, Edward Macfarlane, County Entomologist, Santa Clara Co., Mountain View, Cal. (50). **F**

*Eichelberger, William Snyder, Ph. D., Nautical Almanac Office, U. S. Naval Observatory, Washington, D. C. (41). 1896. **A**

*Eiesland, John, Ph. D., Professor of Mathematics, Thiel College, Greenville, Pa. (50). 1903. **A**

*Eigenmann, Carl H., Ph. D., Indiana University, Bloomington, Ind. (48). 1899. **F**

Eilers, Anton F., Mining Engineer and Metallurgist, 751 St. Marks Ave., Brooklyn, N. Y. (50). **D E**

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*Elkin, William L., Yale University Observatory, New Haven, Conn. (33). 1885. **A**

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Ellis, Frederick W., M. D., Monson, Mass. (47). **B H**

Ellis, H. Bert, M. D., 243–246 Bradbury Block, Los Angeles, Cal. (50). **K**

Ellis, Robert W., Hurley, S. D. (50). **E**

*Elrod, Morton John, Professor of Biology, University of Montana, Missoula, Mont. (50). 1901. **F**

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*Ely, Theo. N., Chief of Motive Power, Pennsylvania R.R., Broad St. Station, Philadelphia, Pa. (29). 1886. **D**

*Emerson, Prof. Benjamin K., Box 203, Amherst, Mass. (19). 1877. **E F**

*Emerson, C. F., Box 499, Hanover, N. H. (22). 1874. **A B**

*Emery, Albert H., Stamford, Conn. (29). 1884. **B D**

Emery, Albert Hamilton, Jr., 312 Main St., Stamford, Conn. (47). **D**

Emmerton, Frederic Augustus, 9 Bratenahl Bldg., Cleveland, Ohio. (50). **I**

Emmons, Arthur B., Newport, R. I. (50). **E**

*Emmons, S. F., U. S. Geol. Survey, Washington, D. C. (26). 1879. **E**

Emory, Hon. Frederic, Chief of the Bureau of Foreign Commerce, State Department, Washington, D. C. (52). **I**

Enders, Howard Edwin, Professor of Biology, Lebanon Valley College, Annville, Pa. (50). **F G**

*Engelman, George J., M. D., 336 Beacon St., Boston, Mass. (25). 1875. **F H**

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Engle, Wilber Dewight, Professor of Chemistry, University of Denver, University Park, Colo. (50). **C**

*Engler, Edmund Arthur, President Worcester Polytechnic Institute, Worcester, Mass. (50). 1901. **A**

English, William Thompson, M. D., Professor of Physical Diagnosis, Western University of Pennsylvania, Pittsburg, Pa. (50). **K**

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Eno, John Chester, Waldorf-Astoria Hotel, New York, N. Y. (49).

Epper, Rev. Frowin, O. S. B., Mt. Angel, Oregon. (50). **F**

Esmond, Darwin W., Newburgh, N. Y. (50). **A I**

Estes, Dana, Brookline, Mass. (29). **H I**

*Evans, Alexander W., M. D., 12 High St., New Haven, Conn. (45). 1903. **G**

Evans, Britton D., M. D., Medical Director of N. J. State Hospital, Morris Plains, N. J. (51). **K**

Evans, Henry Brown, 3009 Cambridge Place, Washington, D. C. (48). **A**

Evans, Samuel G., 211 Main St., Evansville, Ind. (39). **F**

Evans-Carrington, Rev. Edward, 227 E. Cucharras St., Colorado Springs, Colo. (51). **I**

Evans, Walter Harrison, Ph. D., Department of Agriculture, Washington, D. C. (52). **G**

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Evermann, Barton Warren, Ichthyologist and Chief of Division of Fisheries, U. S. Fish Commission, Washington, D. C. (52). F

Evers, Edward, M. D., 1861 N. Market St., St. Louis, Mo. (28). F H

Everts, Orpheus, M. D., Medical Superintendent, The Cincinnati Sanitarium, Sta. K, Cincinnati, Ohio. (51). K

*Ewell, Ervin E., care German Kali Works, Atlanta. Ga. (40). 1896. C

*Eyerman, John, "Oakhurst," Easton, Pa. (33). 1889. C E

Fahrig, Ernst, Chief of Laboratories, Philadelphia Commercial Museum, Philadelphia, Pa. (51).

Faile, Thomas H., Murray Hill Hotel, New York, N. Y. (50).

*Fairbanks, Henry, Ph. D., St. Johnsbury, Vt. (14). 1874. A B D

Fairchild, B. T., P. O. Box 1120, New York, N. Y. (36).

*Fairchild, David Grandison, U. S. Dept. Agriculture, Washington, D. C. (47). 1898. G

*Fairchild, Prof. H. L., Univ. of Rochester, Rochester, N. Y. (28). 1883. E F

Falconer, William, Schenley Park, Pittsburg, Pa. (29).

Falding, Frederic J., Consulting Chemical Engineer, 52 Broadway, New York, N. Y. (50). C

Falk, Gustav, 24 East 81st St., New York, N. Y. (50).

*Fanning, John T., Consulting Engineer, Kasota Block, Minneapolis, Minn. (29). 1885. D

*Fargis, Rev. Geo. A., S. J., Georgetown University, Washington D. C. (40). 1892.

Farley, Godfrey Pearson, C. E., General Manager, W. W. & F. R. R. Co., Wiscasset, Maine. (51). D

*Farlow, Dr. W. G., 24 Quincy St., Cambridge, Mass. (20). 1875. G

Farnsworth, Philo J., M. D., Clinton, Iowa. (50). K

Farquhar, Miss Helen, State Normal School, West Chester, Pa. (50). A B

*Farquhar, Henry. Census Office, Washington, D. C. (33). 1886. A B G I

Farr, Marcus S., Sc. D., Princeton Univ., Princeton, N. J. (49). E

*Farrand, Livingston, M. D., Columbia University, New York, N. Y. (50). 1902 H

Farwell, Elmer S., Steam Engineer, 507 W. 142d St., New York, N. Y. (51). A D

Farwell, Robert Benneson, C. E., 53 Monument Ave., Charlestown, Mass. (47). D

*Fassig, Oliver Lanard, Johns Hopkins University, Baltimore, Md. (46). 1899. B

Fast, Richard Ellsworth, Professor American History and Political Sciences, West Virginia University, Morgantown, W. Va. (50). I

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Faught, John B., Professor of Mathematics, Northern State Normal School, Marquette, Mich. (50). **A**

Fawcett, Ezra, Mechanical and Electrical Engineer, 233 Ely St., Alliance, Ohio. (48). **B D**

Fay, L. G., Naval Office, 20 Exchange Place, New York, N. Y. (50).

Fellows, Charles S., 912 Chamber of Commerce, Minneapolis, Minn. (34). **F**

*Felt, Ephraim Porter, Ph. D., State Entomologist, Albany, N. Y. (44). 1899. **F**

Fenneman, Nevin M., Ph. D., Professor of Geology, University of Colorado, Boulder, Colo. (51). **E**

Fényes, Adalbert, M. D., P. O. Box W, Pasadena, Cal. (51). **F**

Ferguson, Alexander McGowen, Instructor in Botany, Univ. of Texas, Austin, Texas. (51). **G**

Ferguson, L. L., Optician, 155 Broadway, New York, N. Y. (52). **B**

Fernald, F. A., Broadway and 117th St., New York, N. Y. (43). **C**

*Fernow, Bernhard E., Director N. Y. State College of Forestry, Cornell University, Ithaca, N. Y. (31). 1887. **G I**

Ferril, William C., Curator, State Historical and Natural History Society of Colorado, Denver, Colo. (50). **E F G H I**

Ferry, Dexter M., Jr., Seedsman, 1040 Woodward Ave., Detroit, Mich. (50). **G**

*Fessenden, Reginald A., Old Point Comfort, Va. (47). 1899. **A B**

Fetterman, John Colvin, Castle Shannon, Pa. (51). **E F**

*Fewkes, Dr. J. Walter, Bureau of Amer. Ethnology, Washington, D. C. (48). 1900. **H**

Field, George Wilton, Mass. Inst. Tech., Boston, Mass. (47).

Field, W. L. W., Milton, Mass. (47). **F**

Finch, John Wellington, State Geologist, Victor, Colo. (50). **E**

Findlay, Merlin C., Professor of Biology, Park College, Parkville, Mo. (50). **F**

*Fink, Prof. Bruce, Upper Iowa Univ., Fayette, Iowa. (45). 1899. **G**

Finley, Norval Howard, 6638 Deary St., Pittsburg, Pa. (52). **C**

Fireman, Peter, Ph. D., Cosmos Club, Washington, D. C. (45). **D**

*Firmstone, F., Easton, Pa. (33). 1887. **D**

Fischel, Washington E., M. D., 2647 Washington, Ave., St. Louis, Mo. (50). **F K**

Fisher, Louis Albert, U. S. C. and G. Survey, Washington, D. C. (47). **A B C**

Fish, Charles Henry, M. E., General Manager, Cocheco Mf'g Co. Dover, N. H. (51). **D**

*Fish, Pierre A., D. V. S., Ithaca, N. Y. (49). 1901. **K**

Fish, Walter Clark, General Elec. Co., Lynn, Mass. (50). **D**

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Fishburne, Edward Bell, Jr., President Hoge Memorial Military Academy, Blackstone, Va. (51). **D**

Fisher, George E., 37 and 39 Wall St., New York, N. Y. (37).

Fisher, George Egbert, University of Pennsylvania, Philadelphia, Pa. (51).

Fisher, Henry Wright, Electrical Engineer, S. U. Cable Co., Pittsburg, Pa. (51). **D**

*Fisher, Irving, Ph. D., 460 Prospect St., New Haven, Conn. (50). 1901. **A I**

Fisher, Robert Jones, 614 F St., N.W., Washington, D. C. (50). **D**

Fisher, Robert Welles, M. D., 159 E. 2d South St., Salt Lake City, Utah. (51). **K**

Fisher, S. Wilson, 1502 Pine St., Philadelphia, Pa. (51). **A**

Fisk, Herbert F., Principal of the Academy, Northwestern University, Evanston, Ill. (50).

*Fiske, Prof. Thomas S., Columbia University, New York, N. Y. 1901. (50).

Fiske, Wilbur A., Professor of Science, Richmond High School, Richmond, Ind. (51). **B**

*Fitz, George W., M. D., 483 Beacon St., Boston, Mass. (47). 1898. **H**

Fitz Gerald, Francis A. J., P. O. Box 118, Niagara Falls, N. Y. (50), **C.**

Fitzpatrick, Thomas J., Iowa City, Iowa. (52). **G**

Flanders, Charles S., Franklin, Mass. (42). **E**

*Flather, John J., Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn, (44). 1896. **D**

Fleming, John A., U. S. C. and G. Survey, Washington, D. C. (48).

Fleming, Miss Mary A., The Oxford, 432 Pearl St., Buffalo, N. Y. (47). **E G**

Flemming, Dudley D., Gas Engineer, 249 Washington St., Jersey City, N. J. (50). **C D**

*Fletcher, Miss Alice C., Peabody Museum, Cambridge, Mass. (29). 1883. **H**

Fletcher, Andrew, 339 West 77th St., New York, N. Y. (50).

*Fletcher, James, Ph. D., Dominion Entomologist, Experimental Farm, Ottawa, Can. (31). 1883. **F**

*Fletcher, Robert, M. D., Army Medical Museum, Washington, D. C. (29). 1881. **F H**

*Fletcher, Robert, Ph. D., Director of Thayer School of Civil Engineering, Hanover, N. H. (51). 1902. **D**

Flexner, Simon, Univ. of Pennsylvania, Philadelphia, Pa. (52). **K**

Flickinger, Junius R., Sc. D., Principal of Normal School, Pres., Pa. Educational Assn., Normal School, Lock Haven, Pa. (51).

*Flint, Albert S., Washburn Observatory, Madison, Wis. (30). 1887. **A**

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*Flint, Austin, M. D., LL.D., Professor of Physiology, Cornell University Medical College, New York, N. Y. (50). 1901. **F K**

*Flint, James M., Surgeon U. S. N., The Portland, Washington, D. C. (28). 1882. **F**

*Focke, Theodore M., Case School of Applied Science, Cleveland, Ohio. (44). 1903. **A B**

*Foley, Prof. Arthur Lee, Indiana University, Bloomington, Ind. (46). 1900. **B**

Folsom, David M., Stanford University, Cal. (51). **E**

Foote, Allen Ripley, Editor of "Public Policy," Home Insurance Building, Chicago, Ill. (52). **I**

Foote, James S., M. D., Creighton Medical College, Omaha, Neb. (50). **F K**

Foote, Warren M., 1317 Arch St., Philadelphia, Pa. (50). **C**

Forbes, Robert H., Professor of Chemistry, University of Arizona, Tucson, Arizona. (50). **C**

Forcee, Miss Margaret P., M. D., Arch near Ohio St., Allegheny, Pa. (51). **K**

Ford, Prof. Arthur H., Professor of Electrical Engineering, Georgia School of Technology, Atlanta, Ga. (52). **D**

Ford, James B., 4 East 43d St., New York, N. Y. (49).

Fort, I. A., U. P. Land Agent, North Platte, Neb. (51).

Forwood, Gen. William Henry, M. D., U. S. A., 1425 Euclid Place, N.W., Washington, D. C. (52). **K**

Foster, George Winslow, M. D., Medical Superintendent, Eastern Maine Insane Hospital, Bangor, Maine. (52). **K**

Foster, Macomb G., P. O. Box 1120, New York, N. Y. (49).

Foster, William, Newburgh, N. Y. (50). **I**

Foulk, Charles W., Assist. Professor of Analytical Chemistry, Ohio State Univ., Columbus, Ohio. (51). **C**

Fowler, Edwin H., U. S. C. and G. Survey, Washington, D. C. (47).

Fox, Charles James, M. D., Lock Box A, Willimantic, Conn. (51). **K**

Fox, William, Asst. Professor Physics, College of the City of New York, New York, N. Y. (50). **B D**

Foxworthy, Fred. William, Assistant in Botanical Department, Cornell Univ., Ithaca, N. Y. (52). **G**

Fracker, George Cutler, Professor of Philosophy and Psychology, Coe College, Cedar Rapids, Iowa. (52). **H**

Fraenkel, Joseph, M. D., 46 East 75th St., New York, N. Y. (50). **K**

Francis, Charles Kenworthy, Ph. B., Adjunct Prof. of Chemistry, Ga. School of Technology, Atlanta, Ga. (50). **C**

Francisco, M. Judson, 49 Merchants' Row, Rutland, Vt. (50). **I**

*Frankforter, George B., University of Minnesota, Minneapolis, Minn. (43). 1901. **C**

Frankland, Frederick W., 346 Broadway, New York, N. Y. (50).

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*Franklin, Mrs. C. Ladd, 516 Park Ave., Baltimore, Md. (47). 1899. H

*Franklin, Edward Curtis, Ph. D., Kansas State Univ., Lawrence, Kan. (47). 1900. B G

*Franklin, William S., Lehigh University, So. Bethlehem, Pa. (36). 1892. B

*Frazer, Dr. Persifor, Drexel Building, Room 1042, Philadelphia, Pa. (24). 1879. C E

*Frazier, Prof. B. W., Lehigh University, So. Bethlehem, Pa. (24). 1882. C E

*Frear, William, State College, Pa. (33). 1886. C

Frederick, Charles Warnock, U. S. Naval Observatory, Washington, D. C. (50). A B C

Freeborn, George C., M. D., 215 West 70th St., New York, N. Y. (50). K

*Freedman, William Horatio, Professor of Electrical Engineering, University of Vermont, Burlington, Vt. (50). 1901. B D

Freeman, Charles, Ph. D., Director of Clark Chemical Laboratory, Westminster College, New Wilmington, Pa. (50). C

Freeman, Prof. T. J. A., St. John's College, Fordham, New York, N. Y. (33). B C

*Freer, Prof. Paul C., Ann Arbor, Mich. (39). 1891. C

Freley, Jasper Warren, Wells College, Aurora, N. Y. (45). B E

French, E. L., Crucible Steel Co. of America, Syracuse, N. Y. (51). C

French, Owen B., U. S. Coast and Geodetic Survey, Washington, D. C. (52). A D E

*French, Prof. Thomas, Jr., Amherst, Mass., (30). 1883. B

Fretz, Augustus Henry, Doylestown, Pa. (50).

Fretz, John Edgar, M. D., 112 North 3d St., Easton, Pa. (46). F G H

Frick, Prof. John H., Dept. of Mathematics, Central Wesleyan College, Warrenton, Mo. (27). A B E F

Friedenwald, Harry, M. D., Associate Prof. of Ophthalmology and Otology, College of Phys. and Surgs., 1029 Madison Ave., Baltimore, Md. (51). K

Friend, Samuel Henry, M. D., 141 Wisconsin St., Milwaukee, Wis. (51). K

*Fries, Dr. Harold H., 92 Reade St., New York, N. Y. (40). 1898. C

Frisbie J. F., M. D., Box 455, Newton, Mass. (29). E H

*Frisby, Prof. Edgar, U. S. Naval Observatory, Washington, D. C. (28). 1880. A

Frissell, Rev. Hollis Burke, LL. D., Principal of Hampton Normal and Agr. Institute, Hampton, Va. (52). I

Frissell, H. S., President of the Fifth Avenue Bank of N. Y., 5th Ave and 44th St., New York, N. Y. (52). I

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*Frost, Edwin Brant, Yerkes Observatory, Williams Bay, Wis. (38). 1890. **A B**

Frost, George H., C. E., Editor of "Engineering News," 220 Broadway, New York, N. Y. (50). **B D**

Frost, William Dodge, Instructor in Bacteriology, University of Wisconsin, Madison, Wis. (50). **F**

FROTHINGHAM, MRS. FREDERICK, 152 Pawtucket St., Lowell, Mass. (31). **A F I**

Fuller, Arthur Levens, Brunner, Kans. (50). **C**

Fuller, Charles Gordon, M. D., Reliance Building, Chicago, Ill. (35). **F**

*Fuller, George W., 170 Broadway, New York, N. Y. (50). 1903. **K**

*Fuller, Prof. Homer T., President Drury College, Springfield, Mo. (35). 1891. **C E**

*Fuller, Melville W., LL.D., Chief Justice U. S. Supreme Court, 1800 Massachusetts Ave., Washington, D. C. (40). 1901. **I**

FULLER, MYRON L., Assistant Geologist, U. S. Geological Survey, Washington, D. C. (50). **E**

Fullmer, Edward Lawrence, Prof. of Natural Science, Dakota Univ., Mitchell, S. D. (50). **F**

*Fulton, Robert B., Chancellor Univ. of Mississippi, University, Miss. (21). 1887. **A B**

Fulton, Weston Miller, Instructor in Meteorology, University of Tennessee, Knoxville, Tenn. (50). **B**

Furlow, Floyd Charles, Professor of Experimental Engineering, Georgia School of Technology, Atlanta, Ga. (50). **D**

*Furness, Miss Caroline E., Vassar College Observatory, Poughkeepsie, N. Y. (47). 1899. **A**

Furst, Clyde, Secretary of Teachers' College, Columbia University, New York, N. Y. (52).

Gable, George D., Ph. D., Parsons College, Fairfield, Iowa. (40). **A B**

Gaff, Thomas T., 1738 M St., Washington, D. C. (52).

*Gage, Prof. Simon Henry, Cornell University, Ithaca, N. Y. (28). 1881. **F**

*Gage, Mrs. Susanna Phelps, Ithaca, N. Y. (48). 1900. **F**

Gage-Day, Mary, M. D., 207 Wall St., Kingston-on-Hudson, N. Y. (51). **K**

Gager, C. Stuart, Professor of Biologic Science, New York State Normal College, Albany, N. Y. (50). **F G**

Gahagan, William L., M. D., 141 Broadway, New York, N. Y. (51). **K**

*Galbraith, Prof. John, School of Practical Science, Toronto, Can. (38). 1889. **D**

*Galloway, B. T., U. S. Dept. Agriculture, Washington, D. C. (37). 1890. **G**

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*Galloway, Thomas Walton, James Milliken Univ., Decatur, Ill. (45). 1901. F G

*Ganong, Wm. F., Professor of Botany, Smith College, Northampton, Mass. (49). 1900. G

Gantt, Henry Lawrence, Consulting Engineer, care American Locomotive Co., Schenectady, N. Y. (51). D I

Ganz, Albert Frederick, M. E., Professor of Applied Electricity, Stevens Institute, Hoboken, N. J. (52). A B D

Garcin, Ramon D., M. D., 2618 E. Broad St., Richmond, Va. (51). K

Gardiner, Charles Fox, M. D., 818 N. Cascade Ave., Colorado Springs, Colo. (51). K

Gardiner, Edward G., Ph. D., 131 Mt. Vernon St., Boston, Mass. (51).

Gardiner, Rev. Frederic, Jr., Yeates School, Lancaster, Pa. (47). F H

Gardner, Rev. Corliss B., Ripley, N. Y. (29). A B I

Gardner, Geo. Clinton, 416 Beach St., N., Richmond Hill, New York, N. Y. (50).

Garland, Jos. E., M. D., 17 Pleasant St., Gloucester, Mass. (51). K

Garnier, Madame Laure Russell, The Castle, Tarrytown, N. Y. (40).

Garrett, Albert O., 1242 Milton Ave., Salt Lake City, Utah. (50). G

Garriott, Edward B., U. S. Weather Bureau, Washington, D. C. (49).

Garrison, Harriet E., M. D., 105 E. Second St., Dixon, Ill. (51). K

Garver, John A., 44 Wall St., New York, N. Y. (49).

Garvin, John B., Instructor in Chemistry, High School District No. 1. Denver, Colo. (50). C

Gates, Fanny Cook, Instructor in Physics, Woman's College, Baltimore, Md. (50). A B

Gault, Franklin B., 602 N. I St., Tacoma, Wash. (43).

Gause, Fred Taylor, Manager Standard Oil Co. of New York, T. and B. Dept. Yokohama, Japan. (40).

Gauss, Robert, Editor "Denver Republican," Denver, Colo. (50). I

Geisler, Joseph F., New York, Mercantile Exchange, New York, N. Y. (50).

*Genth, Fred. A., 103 N. Front St., Philadelphia, Pa. (32). 1900. C E

*Genthe, Karl Wilhelm, Ph. D., Instructor in Zoology, Trinity College, Hartford, Conn. (50). 1901. F

*Germann, George B., 90 Norman Ave., Brooklyn, N. Y. (49). 1901. A

Getman, Frederick H., Johns Hopkins University, Baltimore, Md. (45). B

*Gibbs, Prof. J. Willard, New Haven, Conn. (33). 1885. B

*Gibbs, Prof. Wolcott, Newport, R. I. (1). 1896. B C

Gibson, George H., Peabody Building, Hyde Park, Mass. (51). D I

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*Gies, William J., College of Physicians and Surgeons, 437 West 59th St., New York, N. Y. (49). 1901. C

Gifford, Harold, M. D., 405 Karbach Block, Omaha, Neb. (51). K

*Gifford, John Clayton, New York State College of Forestry, Ithaca, N. Y. (50). 1902. G

Gilbert, Charles B., Supt. Public Instruction, 106 Brunswick St., Rochester, N. Y. (50). I

*GILBERT, G. K., U. S. Geol. Survey, Washington, D. C. (18). 1874. E

Gilbert, Norman Everett, Professor of Physics, Hobart College, Geneva, N. Y. (51). B

Gilchrist, T. Caspar, 317 N. Charles St., Baltimore, Md. (52).

Gildersleeve, Nathaniel, M. D., Assistant in Bacteriology, Laboratory of Hygiene, University of Pennsylvania, Philadelphia, Pa. (52). K

*Gill, Adam Capen, Cornell University, Ithaca, N. Y. (38). 1894. E

*Gill, Augustus Herman, Mass. Institute Technology, Boston, Mass. (44). 1896. C

*Gill, Theodore Nicholas, M. D., Cosmos Club, Washington, D. C. (17). 1874. F

*Gillette, Clarence P., Professor of Zoology, Agricultural College. Fort Collins, Colo. (50). 1901. F

Gilman, Charles Edward, Stanford University, Cal. (51). E

*Gilman, Daniel C., Johns Hopkins University, Baltimore, Md. (10). 1875. E H

*Girty, George H., Ph. D., U. S. Geol. Survey, Washington, D. C. (48). 1903. E

Glaser, C., Analytical and Consulting Chemist, 21 S. Gay St., Baltimore, Md. (49).

Gleason, H. Allan, Asst. in Botany, Univ. of Illinois, Champaign, Ill. (50). G

Gleason, W. Stanton, M. D., 143 Grand St., Newburgh, N. Y. (50). F K

*Glenn, L. C., Ph. D., Professor of Geology, Vanderbilt University, Nashville, Tenn. (50). 1903. E

*Glenn, William, 1348 Block St., Baltimore, Md. (33). 1893. C

GLENNY, WILLIAM H., Buffalo, N. Y. (25).

Glover, Charles Carroll, 1703 K St. N.W., Washington, D.C. (52). I

Godfrey, Chas. C., M. D., 753 Lafayette St., Bridgeport, Conn. (51). K

Godkin, Mrs. E. L., 36 W. 10th St., New York, N. Y. (49).

*Goessmann, Prof. C. A., Mass. Agric. College, Amherst, Mass. (18). 1875. C

Gold, Rev. Dr. James Douglas, Covington, Ohio. (50). I

*Gold, Theodore S., West Cornwall, Conn. (4). 1887. B C

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Golden, Harry E., Civil Engineer, Mann Building, Utica, N. Y. (51). **D**

*Golden, Miss Katherine E., Purdue University, Lafayette, Ind. (42). 1897. **G**

Goldsborough, John Byron, Croton-on-Hudson, N. Y. (51).

*Goldschmidt, S. A., Ph. D., 43 Sedgwick St., Brooklyn, N. Y. (24). 1880. **B C E**

*Goldsmith, Edw., 658 N. 10th St., Philadelphia, Pa. (29). 1892. **B C**

Goldthwait, James Walter, Assistant in Geology, Harvard University, Cambridge, Mass. (51). **E**

Goldthwaite, Miss Nellie Esther, Mount Holyoke College, So. Hadley, Mass. (47). **C**

Gomberg, Moses, Sc. D., 1101 E. University Ave., Ann Arbor, Mich. (51). **C**

*Gooch, Frank A., Yale University, New Haven, Conn. (25). 1880. **C**

*Goodale, Prof. George Lincoln, Botanic Gardens, Cambridge, Mass. (18). 1875. **G**

Goodale, Joseph Lincoln, M. D., 397 Beacon St., Boston, Mass. (50). **F K**

Goode, John Paul, Instructor in Geography, University of Pennsylvania, Philadelphia, Pa. (52). **E H I**

Goodnow, Henry R., 95 Riverside Drive, New York, N. Y. (32). **B**

*Goodspeed, Arthur Willis, Ph. D., Dept. Physics, University of Pennsylvania, Philadelphia, Pa. (47). 1898. **A B**

Goodwin, Elmer Forrest, Principal and Prof. Physics and Chemistry Concord Branch, West Virginia State Normal School, Athens, W. Va. (50). **B C**

*Goodwin, Harry M., Professor of Physical Chemistry, Mass. Institute Technology, Boston, Mass. (47). 1901. **B**

Goodwin, Rev. James, 76 Garden St., Hartford, Conn. (52). **I**

*Goodyear, William H., Museum of Brooklyn Institute of Arts and Sciences, Eastern Parkway, Brooklyn, N. Y. (43). 1902. **H**

Gordon, Charles Henry, Ph. D., Supt. of Schools and Instructor in Geology and Geography in the Univ. of Nebraska, Lincoln, Neb. (52). **E**

Gordon, Clarence McC., Ph. D., Professor of Physics, Centre College, Danville, Ky. (48). **A B C**

Gordon, Gustavus Ede, Scientific Director, Walker Gordon Laboratory Co., Chevy Chase, Md. (51). **F**

Gordon, Leonard J., M. D., President Free Public Library, Jersey City, N. J. (52). **K**

Gordon, Reginald, 315 W. 71st St., New York, N. Y. (50).

Gordon, Robert H., Cumberland, Md., (48). **E F**

Gore, J. W., Professor Physics, Univ. of N. C., Chapel Hill, N. C. (51). **B**

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*Goss Prof Wm. F. M., Lafayette, Ind. (39). 1896.
Gossard, Harry Arthur, Professor of Entomology, Florida Agricultural College, Lake City, Fla. (51). F
Goucher, John Franklin, President of The Woman's College, Baltimore, Md. (50).
*Gould, George Milbry, M. D., 1631 Locust St., Philadelphia, Pa. (51). 1902. K
Gould, H. P., 1219 13th St., N.W., Washington, D. C. (52). G
Gouldy, Miss Jennie A., Newburgh, N. Y. (50). I
Grabill, H. P., 1004 Enas Ave., Des Moines, Iowa. (50). C
Graef, Edw. L., 58 Court St., Brooklyn, N. Y. (28). F
Graham, Andrew B., 1230 Pa. Ave., N.W., Washington, D. C. (52). I
Graham, Douglas, M. D., 74 Boylston St., Boston, Mass. (51). K
Graham, James Chandler, Chemist, Phillips Academy, Andover, Mass. (50). C
Graham, Robert Dunn, 281 Fourth Ave., New York, N. Y. (50).
Granbery, Julian Hastings, Engineer and Electrician, 561 Walnut St., Elizabeth, N. J. (50). D
Granger, Arthur O., Cartersville, Ga. (50). A B
*Grant, Ulysses Sherman, Ph. D., Professor of Geology, Northwestern University, Evanston, Ill. (50). 1902. E
Grant, Willis Howard, 744 South Ave., Wilkensburg, Pa. (51). C G
Granville, William Anthony, Ph. D., Instructor in Mathematics, Yale University, New Haven, Conn. (50). A
*Gratacap, L. P., 77th St. and 8th Ave., New York, N. Y. (27). 1884. C E F
*Gray, Prof. Thomas, Terre Haute, Ind. (38). 1889. D
Greeff, Ernest F., 37 W. 88th St. New York, N. Y. (49).
*Green, Arthur L., Purdue University, Lafayette, Ind. (33). 1888. C
*Green, Bernard Richardson, Civil Engineer, Supt. of Congressional Library Building, 1738 N St., N.W., Washington, D. C. (51). 1903. B D
Greene, Chas. Lyman, M. D., 150 Lowry Arcade, St. Paul, Minn. (51). K
*Greene, Charles Wilson, Ph. D., Professor of Physiology, State University of Missouri, Columbia, Mo. (50). 1901. F K
Green, Edgar Moore, M. D., Easton, Pa. (36). C G H
Greene, G. K., 127 W. Market St., New Albany, Ind. (38).
Green, Horace, care "Sunday American and Journal," 15 Spruce St., New York, N. Y. (50).
Green, Miss Isabella M., 111 Union Place, Akron, Ohio. (47).
Greene, Jacob L., President Mut. Life Insurance Co., Hartford, Conn. (23).

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Green, Milbrey, M. D., 567 Columbus Ave., Boston, Mass. (29).
Greenalch, Wallace, Deputy City Engineer, Albany, N. Y. (51). D
*Greenman, Jesse M., 875 Doan St., Cleveland, Ohio. (47). 1899. G
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Greenough, John, 31 W. 35th St., New York, N. Y. (49).
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Hoover, Mrs. Lou Henry, care Bewick, Moreing & Co., Broad St. House, New Broad St., London, England. (51). **E**
Hoover, William, Athens, Ohio. (49).
Hopeman, H., M. D., Minden, Neb. (51). **K**
Hopkins, Albert Lloyd, 2904 West Ave., Newport News, Va. (51).
Hopkins, Anderson Hoyt, Assistant Librarian of John Crerar Library, Chicago, Ill. (52).
*Hopkins, A. D., Ph. D., U. S. Department Agriculture, Washington, D. C. (42). 1899. **F**
*Hopkins, Prof. Arthur John, Amherst College, Amherst, Mass. (44). 1900. **C**
Hopkins, George B., 52 Broadway, New York, N. Y. (50).
*Hopkins, Grant S., Cornell University, Ithaca, N. Y. (41). 1900. **F**
*Hopkins, Nevil Monroe, Asst. Professor of Chemistry, Columbian University, Washington, D. C. (48). 1901. **C D**
*Hopkins, Thomas Cramer, Syracuse University, Syracuse, N. Y. (38). 1898. **E**
Hormell, Prof. William G., Ohio Wesleyan Univ., Delaware, Ohio. (48). **B**
Hornung, Christian, Professor of Mathematics and Astronomy, Heidelberg University, Tiffin, Ohio. (50). **A D**
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*Howe, Herbert Alonzo, Director of the Chamberlin Observatory, University of Denver, University Park, Colo. (50). 1901. A

*Howe, Prof. Jas. Lewis, Washington and Lee University, Lexington, Va. (36). 1888. C

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*Howell, Edwin E., 612 17th St., N.W., Washington, D. C. (25). 1891. E

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Hubley, G. Wilbur, Electric Light Co., Louisville, Ky. (52). D

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*Hudson, George H., Vice Principal, Dept. Natural Science, State Normal and Training School, Plattsburgh, N. Y. (31). 1901. F

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Hume, Alfred, C. E., University Miss. (39). A

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Hummel, John A., Experiment Station, St. Anthony Park, Minn. (48).

*Humphrey, Richard L., Testing Laboratory, City Hall, Philadelphia, Pa. (48). 1902. D

Humphreys, Alex. C., M. E., C. E., 31 Nassau St., New York, N. Y. (49).

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*Jayne, Horace, 318 S. 19th St., Philadelphia, Pa. (29). 1884. F H

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*Jennings, Walter L., Worcester Polytechnic Institute, Worcester, Mass. (45). 1898.
Jepson, Wm., M. D., Sioux City, Ia. (51). K
*Jesup, Prof. Henry G., Dartmouth College, Hanover, N. H. (36). 1891. F
*Jesup, Morris K., 44 Pine St., New York, N. Y. (29). 1891. I
Jewell, Lewis E., Johns Hopkins University, Baltimore, Md. (49).
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Jewett, Geo. Franklin, M. D., Forman, N. Dak. (51). K
Jewett, William Cornell, C. E., 541 Ridgeway Ave., Avondale, Cincinnati, Ohio. (52). D
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Johnson, Nels, Manistee, Mich. (41). A B
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Jones, Clement Ross, Professor Mechanical Engineering, West Virginia University, Morgantown, W. Va. (50). **D**

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Jones, Grinnell, Vanderbilt University, Nashville, Tenn. (52). **C**

*Jones, Frederick S., Professor of Physics, University of Minnesota, Minneapolis, Minn. (45). 1901. **B**

*Jones, Lewis Ralph, Professor of Botany, University of Vermont, Burlington, Vt. (41). 1894. **G**

Jones, Lynds, M. Sc., Instructor in Zoology, Oberlin College, Oberlin, Ohio. (50). **F**

*Jones, Prof. Marcus E., Salt Lake City, Utah. (40). 1893. **G**

Jones, Philip Mills, M. D., 1710A, Stockton St., San Francisco, Cal. (50).

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*Jordan, Edwin Oakes, Ph. D., University of Chicago, Chicago, Ill. (50). 1901. **K**

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Juat, Francis, M. D., Aberdeen, N. C. (50). **F K**

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*Julien, Alexis A., N. Y. Academy of Sciences, New York, N. Y. (24). 1875. **C E**

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Kahl, Paul Hugo Isidor, Carnegie Museum, Pittsburg, Pa. (50) **F**

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*Kearney, Thomas H., Jr., U. S. Dept. Agriculture, Washington, D. C. (47). 1902. **G**
*Keasbey, Lindley Miller, Professor of Economics and Politics, Bryn Mawr College, Bryn Mawr, Pa. (51). 1903. **H I**
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Keene, Geo. Fredk., M. D., Supt. State Hospital for the Insane, Howard, R. I. (51). **K**
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Kennedy, George Golding, M. D., Readville, Mass. (40). F G

KENNEDY, HARRIS, 284 Warren St., Roxbury, Mass. (40). E F

Kennedy, Orran W., General Superintendent, Frick Coke Co., Uniontown, Pa. (51). E

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Kent, James Martin, Instructor in Steam and Electricity, Manual Training High School, Kansas City, Mo. (50). D E

Kent, Norton Adams, Ph. D., Professor Physics, Wabash College, Crawfordsville, Ind. (50). A

*Kent, William, Passaic, N. J. (26). 1881. D I

Kenyon, Oscar Curtis, Teacher of Physics, High School, Syracuse, N. Y. (50). B

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Knapp, G. N., Stanton, Minn. (46). G H

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Knowles, Morris, Resident Engineer, Bureau of Filtration, 1017 Frick Bldg., Pittsburg, Pa. (51). D

Knox, Francis H., Electrical Engineer, Spartanburg, S. C. (50). D

Knox, Henry H., Mining Engineer, 110 East 23d St., New York, N. Y. (50). D

Knox, S. L. Griswold, care Bucyrus Company, South Milwaukee, Wis. (50). D

Knox, Wilm, Society for Savings Building, Cleveland, Ohio. (38).

*Kober, Geo. Martin, M. D., 1600 T St., N.W., Washington, D. C. (40). 1896. H

Koenig, Adolph, M. D., Editor "Penna. Medical Journal," 122 Ninth St., Pittsburg, Pa. (50). F G K

*Kofoid, Prof. Charles Atwood, University of California, Berkeley, Cal. (48). 1899. F

Kohnke, Quitman, M. D., Chairman and Health Officer, Board of Health, Cora Building, New Orleans, La. (51). K

Kolbenheyer, Fred'k, M. D., 2006 Lafayette Ave., St. Louis, Mo. (51). K

Koues, Miss Elizabeth L., 282 W. 85th St., New York, N. Y. (41). I

*Kraemer, Prof. Henry, 145 N. 10th St., Philadelphia, Pa. (47). 1901. G

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Kraus, Edward H., Syracuse University, Syracuse, N. Y. (50). **E**
Krause, Otto H., Prospect Ave., Hackensack, N. J. (50).
Krécsy, Prof. Béla, VI Bulyovsxky u. 22, Budapest, Hungary. (41). **C**
*Kremers, Prof. Edward, University of Wisconsin, Madison, Wis. (47). 1901. **C**
Kress, Palmer J., M. D., 636 Hamilton St., Allentown, Pa. (51). **K**
Kretz, Prof. Charles Henry, Asst. Professor Mechanical Engineering, La. State University and A. and M. College, Baton Rouge, La. (50). **D**
*Kroeber, A. L., Ph. D., Univ. of California, Berkeley, Cal. (47). 1901. **H**
Krogstad, Henry, M. D., 1524 K St., N.W., Washington, D. C. (52). **K**
Kuhne, F. W., 19 Court St., Fort Wayne, Ind. (38). **A F**
Kummer, Frederic Arnold, Civil Engineer, President, United States Wood Preserving Co., 29 Broadway, New York, N. Y. (51). **D**
Kunhardt, Wheaton B., 1 Broadway, New York, N. Y. (49).
Kuntze, Dr. Otto, Villa Girola, San Remo, Italy. (49).
*Kunz, G. F., care of Messrs. Tiffany & Co., Union Square, New York, N. Y. (29). 1883. **C E H**
Kúnz, George H., Mohegan, N. Y. (52).
*Lachman, Arthur, Ph. D., 1732 Pacific Ave., San Francisco, Cal. (50). 1901. **C D**
*Ladd, Prof. E. F., Agricultural College, Fargo, No. Dakota. (36). 1889. **C**
Ladd, George Tallman, care Bass Foundry and Machine Co., Fort Wayne, Ind. (51).
La Fetra, Linnaeus Edford, M. D., 58 West 58th St., New York, N. Y. (50). **F H K**
*Laflamme, Prof. J. C. K., Laval University, Quebec, Can. (29). 1887. **B E**
*La Flesche, Francis, 214 First St., S.E., Washington, D. C. (33). 1885. **H**
*Lamb, Daniel S., M. D., 800 10th St., N.W., Washington, D. C. (40). 1894. **H**
*Lambert, Preston A., 215 S. Center St., Bethlehem, Pa. (41). 1896. **A**
Lampard, Henry, 102 Shuter St., Montreal, Can. (40). **C D E**
Lanahan, Henry, Professor Physics and Civil Engineering, Maryland Agricultural College, College Park, Md. (52). **B D**
Lancaster, Walter B., M. D., 101 Newbury St., Boston, Mass. (51). **K**
Land, William Jesse Goad, Dept. Botany, Univ. of Chicago, Chicago, Ill. (52). **G**

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*Landes, Henry, State Geologist, Seattle, Wash. (51). 1903. **E**
Landis, W. W., Dickinson College, Carlisle, Pa. (50).
Landon, Francis G., Staatsburg-on-Hudson, N. Y. (50).
*Landreth, Olin H., Union College, Schenectady, N. Y. (28). 1883. **D**
*LANE, ALFRED C., State Geologist, Lansing, Mich. (50). 1902. **E**
Lane, Horace Manley, M. D., Caixa 14 S. Paulo, Brazil, South America. (46).
Lang, Prof. Henry R., Yale University, New Haven, Conn. (41). **H**
Lange, J. D., 220 W. 79th St., New York, N. Y. (49).
Lange, Philip A., Supt. Westinghouse Elec. and Mfg. Co., Pittsburg, Pa. (50). **D**
*Langenbeck, Karl, Elizabeth, N. J. (39). 1896. **C**
*Langley, Prof. S. P., Smithsonian Institution, Washington, D. C. (18). 1874. **A B**
Langmann, Gustav, M. D., 121 W. 57th St., New York, N. Y. (36).
Langsdorf, Alexander Suss, Instructor in Physics and Electrical Engineering, Washington University, St. Louis, Mo. (50). **B D**
Lanneau, John Francis, Professor of Applied Mathematics and Astronomy, Wake Forest College, Wake Forest, N. C. (50). **A B D**
Lanphear, Burton S., Asst. Professor of Electrical Engineering, Iowa State College, Ames, Ia. (51). **D**
Lansing, John Ernest, Instructor in Natural Sciences, Phillips Academy, Andover, Mass. (52). **B C E**
*Lanza, Prof. Gaetano, Mass. Institute Technology, Boston, Mass. (29). 1882. **A B D**
Laramy, Robert Edward, Teacher in Moravian School, 27 North New St., Bethlehem, Pa. (51). **E**
Lare, H. S. P., M. D., 3452 Park Ave., St. Louis, Mo. (49).
*LARKIN, EDGAR L., Director of Lowe Observatory, Echo Mountain, Cal. (51). 1903. **A**
La Rue, Wm. Gordon, North Freedom, Wis. (50). **D E**
Lathbury, B. Brentnall, C. E., Consulting Chemist, 1619 Filbert St., Philadelphia, Pa. (51). **D.**
Latimer, Thos. S., M. D., 211 W. Monument St., Baltimore, Md. (50). **F H K**
*Lattimore, Prof. S. A., University of Rochester, Rochester, N. Y. (15). 1874. **C**
Lauder, George, 7403 Penn Avenue, Pittsburg, Pa. (50).
*Laudy, Louis H., Ph. D., School of Mines, Columbia University, New York, N. Y. (28). 1890. **C**
Lauman, George Nieman, Instructor in Horticulture, Cornell University, Ithaca, N. Y. (50). **G**
Law, Benedict W., 693 Lafayette Ave., Brooklyn, N. Y. (45). **E**

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Lawbaugh, Elmer Arthur, Oregonian Building, Portland, Oregon. (52). K

Lawrance, J. P. S., Past Assistant Engineer U. S. N., Navy Dept., Washington, D. C. (35). D

Lawrence, A. E., 53 Devonshire St., Boston, Mass. (49).

Lawrence, Harry E., Univ. of Rochester, Rochester, N. Y. (44). B

Lawrence, James W., Professor of Mechanical Engineering, Agricultural College, Fort Collins, Colo. (50). D

Laws, Frank Arthur, Mass. Institute Technology, Boston, Mass. (47).

Laws, Samuel Spahr, 1733 Q St., N.W., Washington, D. C. (52). H

*Lawson, Andrew C., Professor of Geology and Mineralogy, University of California, Berkeley, Cal. (50). 1901. E

Lay, Henry Champlin, Civil and Mining Engineer and Geologist, U. S. Deputy Mineral Surveyor, Telluride, Colo. (51). D E

Lazell, Ellis W., Ph. D., 1619 Filbert St., Philadelphia, Pa. (51). C

*Lazenby, W. R., Columbus, Ohio. (30). 1882. B I

*Leach, Miss Mary F., 74 Pitcher St., Detroit, Mich. (44). 1896. C

*Leaming, Edward, 437 West 59th St., New York, N. Y. (50). 1901. C

Leathers, W. S., Professor of Biology, University of Mississippi, University P. O., Miss. (50). F

Leavitt, Frank M., Mechanical Engineer, 258 Broadway, New York, N. Y. (51). D

*Le Baron, John Francis, Civil and Mining Engineer, 1329 Williamson Bldg., Cleveland, Ohio. (51). 1903. E

Le Boutillier, Roberts, E. Washington Avenue, Germantown, Philadelphia, Pa. (47). G

*Le Brun, Mrs. Michel M., 8 Mountain Ave., S., Montclair, N. J. (35). 1892. F

Le Conte, Louis Julian, Civil Engineer, P. O. Box 482, Oakland, Cal. (51). D

Le Conte, Robert Grier, M. D., 1625 Spruce St., Philadelphia, Pa. (51). K

*Ledoux, Albert R., Ph. D., 99 John St., New York, N. Y. (26). 1881. C

Lee, Benjamin, M. D., Secretary State Board of Health, 1420 Chestnut St., Philadelphia, Pa. (51). K

Lee, Francis Valentine T., Electrical Engineer, 31 and 33 New Montgomery St., San Francisco, Cal. (50). D

*Lee, Frederic S., Adjunct Professor of Physiology, Columbia University, New York, N. Y. (49). 1901. K

Lee, Leslie A., Professor of Biology, Bowdoin College, Brunswick, Me. (52). F

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Lee, Waldemar, Palmerton, Pa. (50).

Lee, William George, Harvard Medical School, Boston, Mass. (50). **H K**

Lee, Prof. Willis Thomas, Johns Hopkins Univ., Baltimore, Md. (47). **E F**

Leeds, Morris E., 3221 North 17th St., Philadelphia, Pa. (50). **D**

*Lefavour, Prof. Henry, The Westminster, Boston, Mass. (42). 1894.

Le Grand, Leroy, M. D., Graham, Texas. (50). **F K**

*Lehmann, G. W., Ph. D., City Hall Annex, Baltimore, Md. (30). 1885. **B C**

Lehmann, Leslie P., 32 South St., Baltimore, Md. (52).

Lehnartz, W., 173 S. Union St., Grand Rapids, Mich. (51).

Leidy, Joseph, Jr., M. D., 1319 Locust St., Philadelphia, Pa. (51). **K**

Leisen, Theo. Alfred, Civil Engineer, Wilmington, Del. (51). **B C D G**

Leiter, L. Z., Dupont Circle, Washington, D. C. (40).

Lemley, C. McC., Asst. Engineer, B. & O. R.R. Co., Philippi, W. Va. (51). **D**

Lemon, James S., Ph. D., 31 Park St., Gardner, Mass. (51). **I K**

Lemp, William J., cor. Cherokee St. and 2d Carondelet Avenue, St. Louis, Mo. (27).

Lender, Mrs. Julia A., 2201 Lincoln Ave., Denver, Colo. (50). **A B**

Lengfeld, Felix, Ph. D., Consulting and Manufacturing Chemist, 202 Stockton St., San Francisco, Cal. (51). **C**

Lenher, Victor, Ph. D., Assistant Professor of Chemistry, Univ. of Wisconsin, Madison, Wis. (52). **C**

*Lennon, William H., Brockport, N. Y. (31). 1894. **C G**

Leonard, Chas. Lester, M. D., 112 S. 20th St., Philadelphia, Pa. (51). **K**

Leonard, John William, Editor of "Who's Who in America," Wheaton, Ill. (50). **I**

Leonard, Percy Allan, Editor of "Ores and Metals," P. O. Box 364, Denver, Colo. (50). **E**

Leslie, Miss Augusta, Newburgh, N. Y. (50). **I**

Letson, Miss Elizabeth J., 366 Mass. Ave., Buffalo, N. Y. (47).

*Leverett, Frank, Ann Arbor, Mich. (37). 1891. **E**

Levine, Edmund J., The Fiberloid Co., 638 Broadway, New York, N. Y. (49).

Lewis, Clarence McKenzie, care Wm. Salomon & Co., 25 Broad St., New York, N. Y. (47). **D**

Lewis, George Smith, 746 State St., Springfield, Mass. (44). **G**

Lewis, Howard W., Banker, 1928 Spruce St., Philadelphia, Pa. (51). **I**

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*Lewis, Joseph Volney, Professor of Geology, Clemson College, S. C. (45). 1900. C E

Lewis, Wilfred, Pres. The Tabor Mfg. Co., 5901 Drexel Road, Philadelphia, Pa. (51). D

*Libbey, Prof. William, Princeton, N. J. (29). 1887. E F

Lichthardt, G., Jr., 18th and M Sts., Sacramento, Cal. (50). C

Lichty, Daniel, M. D., Masonic Temple, Rockford, Ill. (52). K

Lichty, Milton J., M. D., Cor. Genesee St. and Hough Ave., Cleveland, Ohio. (50). F K

Lightfoot, Thos. Montgomery, Asst. Prof. of Physical Science, Central High School, Philadelphia, Pa. (51). G

*Lillie, Frank R., Professor of Zoology, University of Chicago, Chicago, Ill. (50). 1901. F

Lincoln, Paul Martyn, Electrical Engineer, Pittsburg, Pa. (50). D

*Lindenkohl, Adolphus, U. S. C. and G. Survey, Washington, D. C. (40). 1898. E

Lindenkohl, Henry, U. S. C. and G. Survey, Washington, D. C. (47).

*Lindenthal, Gustav, C. E., 45 Cedar St., New York, N. Y. (37.) 1891. I

Linder, Oliver A., 35 Clark St., Chicago, Ill. (49).

Lindgren, Waldemar, U. S. Geological Survey, Washington, D. C. (52). E

Lindley, Ernest H., Professor Psychology, University of Indiana, Richmond, Ind. (52). K

Lindsay, Alexander M., Rochester, N. Y. (41).

Lindsey, Edward, Warren, Pa. (48). H I

Linford, James Henry, President of the Brigham Young College, Logan, Utah. (52). F

*Ling, Charles Joseph, Instructor in Physics, Manual Training High School, Denver, Colo, (50). 1901. A B

Ling, George Herbert, Ph. D., Tutor in Mathematics, Columbia University, New York, N. Y. (52). A

Link, Theodore Carl, Carleton Bldg., St. Louis, Mo. (51). I

*Linn, Alvin Frank, Ph. D., Professor of Chemistry, Wittenberg College, Springfield, Ohio. (50). 1901. C

Linn, George A., M. D., Monongahela, Pa. (51). K

Linton, Edwin, Biological Laboratory, Washington and Jefferson College, Washington, Pa. (51). F

Linville, Henry R., 509 West 112th St., New York, N. Y. (49).

Lion, Léon Elie, C. E., Assistant on U. S. Engineer Corps, 1010 Burgundy St., New Orleans, La. (51). D

Litchfield, Lawrence, M. D., 5431 Fifth Ave., Pittsburg, Pa. (51). K

*Littell, Frank B., U. S. Naval Observatory, Washington, D. C. (49). 1903. A

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Little, C. A., Analyst at Lorain Steel Works, Box 517, Elyria, Ohio. (50). **C**

Little, Henry P., Superintendent of Union Schools, Momence, Ill. (50). **B**

Littlehales, G. W., U. S. Hydrographic Office, Washington, D. C. (52). **A B D E**

Livermore, Mrs. M. A. C., 59 Brewster St., Cambridge, Mass. (29). **F**

Lloyd, Andrew J., 310 Boylston St., Boston, Mass. (47). **B H**

*Lloyd, Francis E., Teachers' College, Columbia University, New York, N. Y. (48). 1901. **G**

*Lloyd, John Uri, Court and Plum Sts., Cincinnati, Ohio. (38). 1890. **C F**

Lloyd, Morton Githens, Ph. D., National Bureau of Standards, Washington, D. C. (52). **B**

Lloyd, Thomas Mortimer, M. D., 125 Pierrepont St., Brooklyn, N. Y. (51). **K**

Lobenstine, William C., 245 Central Park, W., New York, N. Y. (49).

Lochhead, William, Professor of Biology, Ontario Agricultural College, Guelph, Ontario, Can. (51). **F**

Lockwood, Cornelius Wygant, Teacher of Science, Newburgh Academy, Newburgh, N. Y. (50). **B E**

Lockwood, Edwin Hoyt, Asst. Prof. Mechanical Engineering, Yale University, New Haven, Conn. (50). **D**

Loeb, Leo, M. D., Pathological Lab., McGill Univ., Montreal, Can. (51). **K**

*Loeb, Morris, Ph. D., 118 W. 72d St., New York, N. Y. (36). 1889. **C**

*Loew, Dr. Oscar, Komaba, Tokyo, Japan. (49). 1900. **G**

Loewy, Benno, 206 and 208 Broadway, New York, N. Y. (41).

Logan, F. G., 2919 Prairie Ave., Chicago, Ill. (42). **H**

Logan, Walter S., 27 William St., New York, N. Y. (36).

Lomb, Adolph, P. O. Drawer 1033, Rochester, N. Y. (41).

Lomb, Henry, P. O. Drawer 1033, Rochester, N. Y. (41).

Lomb, Henry C., P. O. Drawer 1033, Rochester, N. Y. (43).

*Long, Prof. John H., 2421 Dearborn St., Chicago, Ill. (41). 1895. **C**

Long, William Henry, Jr., Denton, Texas. (50).

*Longden, A. C., Ph. D., Professor of Physics, Knox College, Galesburg, Ill. (49). 1901. **B**

Loomis, Frederick B., Ph. D., Assistant in Zoology, Amherst College, Amherst, Mass. (50). **F**

*Loubat, le Duc de, 47 rue Dumont d'Urville, Paris, France. (46). 1897. **H**

*Loud, Frank H., Colorado Springs, Colo. (29). 1890. **A B**

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Louderback, George Davis, Professor of Geology, Nevada State University, Reno, Nev. (50). **E**

*Lough, J. E., New York University, Washington Square, New York, N. Y. (50). 1901. **I**

*Loughridge, Dr. R. H., Univ. of California, Berkeley, Cal. (21). 1874. **C E**

*Love, Edward G., 80 E. 55th St., New York, N. Y. (24). 1882. **C**

Lovejoy, J. R., Genl. Elec. Co., Schenectady, N. Y. (50). **D**

LOVELAND, HORACE HALL, M. D., Michigamme, Mich. (51). **K**

*Lovett, Edgar Odell, Professor of Mathematics, Princeton University, Princeton, N. J. (51). 1902. **A**

Lovett, Miss Mary, 293 Golden Hill, Bridgeport, Conn. (52). **F G**

Low, A. A., Columbia Heights, Brooklyn, N. Y. (43). A.

*Low, Seth, Mayor of City of New York, New York, N. Y. (29). 1890.

Lowber, Rev. James William. Ph. D., 113 East 18th St., Austin, Texas. (50). **H I**

Lowell, Mrs. Charles Russell, 120 East 30th St., New York, N. Y. (49).

*Lowell, Percival, 53 State St., Boston, Mass. (36). 1896. **A**

Lowell, Russell C., 167 Ohio Ave., Providence, R. I. (51).

Lucas, Anthony F., Mining Engineer, 1406 16th St. N.W., Washington, D. C. (50). **D E**

Luckey, John Eddy, M. D., Vinton, Ia. (51). **I K**

*Ludlow, Jacob Lott, C. E., 434 Summit St., Winston, N. C. (50). **B D**

Luebkert, Otto J. J., U. S. Dept. Agriculture, Washington, D. C. (50). **G**

Lufkin, Albert, Newton, Iowa. (31). **D E**

Lull, Richard S., Amherst, Mass. (43). **F H**

Lund, James, 142 Hawthorne St., Malden, Mass. (45).

Lundin, Carl A. R., care Messrs. Alvan Clark and Sons, Cambridgeport, Mass. (47). **A**

*Luquer, Lea McIlvane, Columbia University, New York, N. Y. (49). 1902. **E**

Lusk, Major James L., U. S. A., U. S. Engineer Office, Rock Island, Ill. (52). **D**

Luther, Miss Agnes Vinton, 917 Broad St., Newark, N. J. (47). **E**

*Lyford, Edwin F., Springfield, Mass. (33). 1896. **B C H**

Lyle, Benjamin F., M. D., 2302 W. Eighth St., Cincinnati, Ohio. (51). **K**

*Lyle, David A., Major U. S. Army, Augusta Arsenal, Augusta, Ga. (28). 1880. **D**

LYMAN, BENJ. SMITH, 708 Locust St., Philadelphia, Pa. (15). **E**

Lyman, Chester W., Assistant to President of International Paper Co., 30 Broad St., New York, N. Y. (50). **I**

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Lyman, Henry H., F. R. G. S., F. E. S., 74 McTavish St., Montreal, Can. (29). **E F**

Lyman, James, Assist. Engineer, Genl. Elec. Co., 1047 Monadnock Bldg., Chicago, Ill. (50). **D**

Lynch, William H., Principal Mountain Grove School, Mountain Grove, Mo. (52). **I**

Lyons, Albert Brown, M. D., Consulting Chemist, 72 Brainard St., Detroit, Mich. (50). **C K**

Lyons, Robert E., Professor of Chemistry, University of Indiana, Bloomington, Ind. (51). **C**

*Mabery, Prof. C. F., Case School of Applied Science, Cleveland, Ohio. (29). 1881. **C**

McAdam, D. J., Teacher of Mathematics, Washington and Jefferson College, Washington, Pa. (51). **A**

McAllister, Cloyd North, Ph. D., Instructor in Psychology, Yale University, New Haven, Conn. (52). **K**

McAllister, Henry, Jr., Attorney at law, 512 Mining Exchange Building, Colorado Springs, Colo. (51).

McAlpin, C. W., 55 W. 33d St., New York, N. Y. (50).

McAlvin, J. G., M. D., Grundy Center, Iowa. (52). **K**

McArthur, Lewis L., M. D., 100 State St., Chicago, Ill. (51). **K**

Macbeth, George A., Trustee Carnegie Institute, Pittsburg, Pa. (50). **D H**

McBride, Hon. George Wickliffe, U. S. Comm'r La. Purchase Exposition, P. O. Box 173, Washington, D. C. (51). **I**

McBride, Jas. H., M. D., Pasadena, Cal. (51). **K**

*Macbride, Thomas H., Iowa City, Iowa. (38). 1890. **G**

McCalley, Henry, Chief Assist. State Geologist, University, Ala. (50). **E**

McCartney, Dr. James H., Room 501 Granite Building, Rochester, N. Y. (41). **A B**

*McCauley, C. A. H., Colonel and Deputy Quartermaster-General, U. S. A., Manila, P. I. (29). 1881.

McClelland, James H., M. D., 5th and Wilkins Aves., Pittsburg, Pa. (50). **F K**

*McClintock, Emory, Morristown, N. J. (43). 1895. **A**

McClung, Clarence E., Ph. D., Professor of Zoology, University of Kansas, Lawrence, Kan. (52). **F**

McCormick, Henry Dreer, M. D., Little Falls, N. J. (51). **K**

McCoy, Lucinius S., Whitten, Hardin Co., Iowa. (50). **A**

*McCreath, Andrew S., 223 Market St., Harrisburg, Pa. (33). 1889. **C E**

McCune, M. Virginia, M. D., 506 West John St., Martinsburg, W. Va. (51). **K**

McCurdy, Arthur W., 143 Bloor St., West, Toronto, Ontario, Can. (52).

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*McCurdy, Charles W., Ph. D., Witherspoon Building, Philadelphia, Pa. (35). 1895. **E F**

MacCracken, John Henry, Ph. D., President of Westminster College, Fulton, Mo. (52). **I**

*MacCurdy, George Grant, Ph. D., 237 Church St., New Haven, Conn. (48). 1900. **H**

McCurdy, Hansford M., Manual Training High School, Kansas City, Mo. (51). **F G**

McDermott, Rev. P. A., Pittsburg College of the Holy Ghost. Bluff and Cooper Sts., Pittsburg, Pa. (51). **E H I**

McFarland, Joseph, M. D., 442 West Stafford St., Philadelphia, Pa. (52). **K**

Macdonald, Benjamin J., 296 Grand St., Newburgh, N. Y. (50). **I**

McDonnell, Curtis C., Asst. Chemist Agric. Exper. Station, Clemson College, S. C. (51). **C**

*McDonnell, Prof. Henry B., College Park, Md. (40). 1893. **C**

*MacDougal, Daniel T., N. Y. Botanical Garden, Bronx Park, New York, N. Y. (44). 1897. **G**

MacDougall, George R., 131 West 73d St., New York, N. Y. (49).

*MacDougall, Robert, Ph. D., Sedgwick Park, University Heights, New York, N. Y. (49). 1901. **H K**

McFadden, L. H., Westerville, Ohio. (32). **B C**

McFadden, Thomas Gilbert, Lebanon Valley Coll., Annville, Pa. (48). **C**

MacFarland, W. W., 22 William St., New York, N. Y. (49).

*Macfarlane, A., Gowrie Grove, Chatham, Ontario, Can. (34). 1886. **A B**

Macfarlane, James R., President Academy of Science and Art, Pittsburg, Pa. (50). **E**

*Macfarlane, John M., Lansdowne, Pa. (41). 1899. **F G**

McGahan, Chas. F., M. D., Bethlehem, N. H. (51). **K**

*McGee, Dr. Anita Newcomb, 1901 Baltimore St., Washington, D. C. (37). 1892. **H**

McGee, D. W., Farley, Iowa. (50). **E**

McGee, Miss Emma R., Box 197, Farley, Iowa. (33). **H**

McGee, John Bernard, M. D., 1405 Woodland Ave., Cleveland, Ohio. (51). **H K**

*McGee, W J, Ph. D., Bureau Amer. Ethnology, Washington, D. C. (27). 1882. **E H**

*McGill, John T., Ph. D., Vanderbilt University, Nashville, Tenn. (36). 1888. **C**

McGregor, James Howard, Columbia University, New York, N. Y. (52). **F**

*McGregory, Prof. J. F., Colgate University, Hamilton, N. Y. (35). 1892. **C**

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*McGuire, Joseph D., 1834 16th St., Washington, D. C. (51). 1902. H

McHatton, Henry, M. D., Macon, Ga. (52). K

MacIntyre, Miss Lucy, 303 West 74th St., New York, N. Y. (49).

Mack, Jacob W., 92 Liberty St., New York, N. Y. (49).

McKeag, Miss Anna J., 14 East 16th St., New York, N. Y. (51). H

McKee, George C., care The Wm. Tod Co., Youngstown, Ohio. (48). A B D

McKelvy, William H., M. D., President Board of Education, 420 6th Ave., Pittsburg, Pa. (50). I

*McKenney, Randolph Evans Bender, Ph. D., Department of Agriculture, Washington, D. C. (51). 1903. G

McKeown, W. W., Jr., Mining Engineer, Room 607, No. 160 Washington St., Chicago, Ill. (51). D E

McKinney, Thomas Emery, Professor of Mathematics and Astronomy, Marietta College, Marietta, Ohio. (50). A

McLain, Louis Randolph, Pres. of Florida Engineering Co., St. Augustine, Fla. (51). D

McLanahan, George William, 1601 21st St. N.W., Washington, D. C. (50).

MacLaren, Archibald, M. D., Lowny Bldg., 350 St. Peter St., St. Paul, Minn. (51). K

McLaughlin, A. C., Houston Oil Co. of Texas, Houston, Texas, (52). C D E

McLaughlin, George Eyerman, M. D., 41 Crescent Ave., Jersey City, N. J. (47). F H

McLaughlin, Thomas N., 1226 N St., N. W., Washington, D. C. (52).

McLaury, Howard L., Prof. of Mathematics and Physics, So. Dakota School of Mines, Rapid City, So. Dak. (50). A B

McLean, Simon James, Ph. D., Professor of Economics and Sociology, University of Arkansas, Fayetteville, Ark. (51). I

*McLennan, J. C., Professor of Physics, Toronto University, Toronto, Ontario, Can. (51). 1903. B

McLimont, Andrew Wingate, Electrical Engineer, Linares, Nuevo Leon, Mexico. (51). D

MacLean, George Edwin, President of the State University of Iowa, Iowa City, Iowa. (52). I

*Macloskie, Prof. George, Princeton Univ., Princeton, N. J. (25). 1882. F G

McMahan, Charles Hays, E. M., Supt. Sombrerete Mining Co., Sombrerete, Zacatecas, Mexico. (50). E

*McMahon, Prof. James, Cornell University, Ithaca, N. Y. (36). 1891. A

McMillan, Smith B., Signal, Ohio. (37).

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McMillin, Emerson, 40 Wall St., New York, N. Y. (37).

McMullen, Joseph Francis, 1908 Nora Ave., Spokane, Washington. (52). **E G**

*McMurtrie, William, 100 William St., New York, N. Y. (22). 1874. **C**

*McNair, Fred Walter, President Michigan College of Mines, Houghton, Michigan. (51). 1902. **B D**

McNeil, Hiram Colver, Teacher of Chemistry and Physics, Shurtleff College, Upper Alton, Ill. (51). **B C**

*McNeill, Malcolm, Professor Mathematics and Astronomy, Lake Forest University, Lake Forest, Ill. (32). 1885. **A**

MacNeille, Perry Robinson, 155 William St., Orange, N. J. (51).

McNulty, Geo. Washington, Civil Engineer, 258 Broadway, New York, N. Y. (51). **D**

McNulty, John J., Ph. D., College of City of New York, New York, N. Y. (50).

*MacNutt, Barry, Lehigh University, So. Bethlehem, Pa. (47). 1900. **B**

*McPherson, Prof. Wm., Ohio State Univ., Columbus, Ohio. (45). 1898. **C**

McPherson, William D., 58 Hartford St., So. Framingham, Mass. (47).

McQueeney, Francis J., M. D., 46 Dartmouth St., Boston, Mass. (51). **K**

Machalske, Florentin J., Ph. D., Analytical and Consulting Chemist, P. O. Box 25, Station W, Brooklyn, N. Y. (52). **C**

Maclay, James, Ph. D., Adjunct Professor of Mathematics, Columbia University, New York, N. Y. (52). **A**

MacVannel, John Angus, Instructor in Philosophy and Education, Columbia University, New York, N. Y. (52). **I**

Macy, V. Everit, 68 Broad St., New York, N. Y. (49).

Magee, Jas. Francis, 114 N. 17th St., Philadelphia, Pa. (51). **C**

Magee, Louis J., Electrical Engineer, Grosse Quer Allee 1, Berlin, Germany. (50). **B D**

*Magie, Prof. Wm. Francis, Princeton University, Princeton, N. J. (35). 1887.

Magill, Arthur Edward, Hotel Stratford, Washington, D. C. (52). **C**

Magill, Dr. Wm. Seagrove, Dry Milk Co., 11 Broadway, New York, N. Y. (52). **K**

Magnusson, Carl Edward, Ph. D., Prof. of Physics, University of New Mexico, Albuquerque, N. M. (51). **D**

Magruder, Egbert W., Chemist, Department of Agriculture, Richmond, Va. (51). **C**

*Magruder, Wm. T., Ohio State Univ., Columbus, Ohio. (37). 1899.

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Mahin, John William, Teacher in Manual Training High School, Denver, Colo. (50). **B C E**

Mahoney, Stephen A., M. D.,206 Maple St., Holyoke, Mass. (51). **K**

Major, David R., Ph. D., Prof. of Education, Ohio State University, Columbus, Ohio. (51). **H I**

Makuen, G. Hudson, M. D., 1419 Walnut St., Philadelphia, Pa. (51). **K**

Mallet, J. W., University of Virginia, Charlottesville, Va. (52).

Mallinckrodt, Edw., P. O. Sub-Station A, St. Louis, Mo. (29). **C**

Mally, Charles William, Dept. Agric., Cape Town, So. Africa. (46).

Mally, Fred'k William, Garrison, Tex. (50). **F G**

Malm, John Lawrence, Marysville, Mont. (50). **C E**

*Maltby, Margaret E., Ph. D., Barnard College, New York, N. Y. (46). 1898.

Mangan, Daniel C., M. D., 95 Park Ave., Brooklyn, N. Y. (50). **F K**

Manley, Thomas Henry, M. D., 115 West 49th St., New York, N. Y. (51). **K**

Mann, Albert, Ph. D., 18 Summit St., East Orange, N. J. (43). **G**

*Mann, B. Pickman, 1918 Sunderland Place, Washington, D. C. (22). 1874. **F I**

Mann, Paul Blakeslee, 45 East Avenue, Ithaca, N. Y. (52). **F**

Manning, Charles H., U. S. N., Manchester, N. H. (35). **D**

Manning, Miss Eva, 1330 Columbia Road, Washington, D. C. (52). **E H**

Manning, J. Woodward, 1150 Tremont Building, Boston, Mass. (47). **G**

Manning, Warren H., Brookline, Mass. (31). **E F H**

Mansfield, Albert K., 125 Lincoln Ave., Salem, Ohio. (51). **D**

Manson, Marsden, Comm'r of Public Works, 2010 Gough St., San Francisco, Cal. (51). **D**

Mapes, Charles Victor, 60 W. 40th St., New York, N. Y. (37). **C**

Marble, J. Russel, Worcester, Mass. (31). **C E**

Marble, Manton, Bedford, N. Y. (36).

Marble, Milton M., Instructor in Physics, Hillhouse High School, New Haven, Conn. (50). **B**

Marble, Miss Sarah, Woonsocket, R. I. (29). **C**

*Marindin, Henry Louis, U. S. C. and G. Survey, Washington, D. C. (40). 1898. **E**

*Mark, Prof. E. H., Superintendent of Public Schools, Center and Walnut Sts., Louisville, Ky. (39). 1893. **B**

*Mark, Edward Laurens, Director Zoological Laboratory, Harvard University, Cambridge, Mass. (50). 1901. **F**

Markham, George Dickson, 4961 Berlin Ave., St. Louis, Mo. (50).

Marks, Louis B., 687 Broadway, New York, N. Y. (50).

Marks, William Dennis, C. E., The Art Club, Philadelphia, Pa. (50). **I**

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Marlatt, Miss Abby L., Manual Training High School, Providence, R. I. (48).

*Marlatt, Charles L., U. S. Department Agriculture, Washington, D. C. (40). 1895. F

Marlow, Frank William, M. D., 200 Highland St., Syracuse, N. Y. (50). F H I K

Marmor, Rev. J. D., 1812 McCulloh St., Baltimore, Md. (52). E H K

Marple, Charles A., 743 Third Ave., Louisville, Ky. (39). B

Marsden, Samuel, 1015 N. Leffengwell Ave., St. Louis, Mo. (27). A D

*Marsh, C. Dwight, Ripon College, Ripon, Wis. (34). 1893. E F

Marsh, James P., M. D., 1828 5th Ave., Troy, N. Y. (51). K

Marshall, Clara, M. D., 1712 Locust St., Philadelphia, Pa. (51). K

Marshall, Horace Miller, U. S. Engineer Office, Vicksburg, Miss. (51). D

Marsters, Vernon, Indiana University, Bloomington, Ind. (49).

Marston, Edwin S., 291 Clinton Ave., Brooklyn, N. Y. (50).

*Martin, Artemas, Ph. D., LL.D., U. S. Coast and Geodetic Survey, Washington, D. C. (38). 1890. A

*Martin, Daniel S., 126 Macon St., Brooklyn, N. Y. (23). 1879. E F

Martin, F. W., Ph. D., Dir. Chem. Lab., Randolph-Macon Women's College, College Park, Va. (49). C

*Martin, George C., Assistant Geologist, Maryland Geological Survey, Johns Hopkins University, Baltimore, Md. (51). 1903. E

Martin, Geo. W., Professor of Biology, Vanderbilt University, Nashville, Tenn. (52). F

Martin, William Lyon, Augusta, Ga. (50). H

*Marvin, C. F., U. S. Weather Bureau, Washington, D. C. (39). 1892. B

*Marvin, Frank O., Dean School of Engineering, University of Kansas, Lawrence, Kan. (35). 1894. D

Marvin, Harry Norton, 11 E. 14th St., New York, N. Y. (50). D

Marvin, Joseph B., M. D., LL.D., President Kentucky University, Louisville, Ky. (51). I

Marvin, Walter T., 36 Knox St., Cleveland, Ohio. (50). H I

Mason, Amos Lawrence, M. D., Physician to Boston City Hospital, 265 Clarendon St., Boston, Mass. (50). K

Mason, Lewis D., M. D., 171 Joralemon St., Brooklyn, N. Y. (51). K

Mason, Miss Nellie M., Teacher of Science, Abbot Academy, Andover, Mass. (50). B C

*Mason, Otis T., U. S. National Museum, Washington, D. C. (25). 1877. H

*Mason, Dr. William P., Rensselaer Polytechnic Inst., Troy, N. Y. (31). 1886. C

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Massey, Wilbur Fisk, Botanist and Horticulturist, Agricultural Exper. Station, Raleigh, N. C. (51). **G**

Mast, Samuel Ottnear, Holland, Mich. (52).

Matas, Rudolph, M. D., Professor of Surgery, Tulane University, New Orleans, La. (50). **H K**

Mateer, Horace N., M. D., Wooster, Ohio. (36). **E F**

*Mathews, John A., Ph. D., Crucible Steel Co, of America, Experimental Dept., Syracuse, N. Y. (50). 1902. **C E**

Mathews, Miss Mary Elizabeth, Painesville, Ohio. (41). **F**

Matlack, Charles, "Hidden Hearth," Matunuck, R. I. (27). **I**

Matlack, Ellwood V., Sec'y and Mgr. Laclede Power Co., St. Louis, Mo. (50). **D**

Matthes, Francois E., U. S. Geological Survey, Washington, D. C. (52). **E**

Matthews, Albert, 145 Beacon St., Boston, Mass. (51). **H**

Matthews, Rodolph, D. D. S., 128 N. Main St., Wichita, Kansas. (50). **C F**

*Matthews, Dr. Washington, 1262 N. H. Ave., Washington, D. C. (37). 1888. **H**

Mattison, Fitch C. E., M. D., Stowell Building, Pasadena, Cal. (51). **K**

Mattoon, A. M., Scott Observatory of Park College, Parkville, Mo. (47). **A**

Maxon, William R., U. S. National Museum, Washington, D. C. (49).

Maxwell, Fred. Baldwin, Ph. D., 308 Franklin Ave., River Forest, Oak Park P. O., Ill. (51). **F**

Maxwell, George H., Chairman Executive Committee, National Irrigation Association, 1827 Phelps Place, Washington, D. C. (50). **E**

Maxwell, Hu., Treasurer Transallegheny Historical Society, Morgantown, W. Va. (50). **E**

*Mayer, Alfred Goldsborough, S. D., M. E., Museum Brooklyn Institute, Eastern Parkway, Brooklyn, N. Y. (47). 1900. **F**

Maynard, George C., 1407 15th St., Washington, D. C. (35). **B D**

Maynard, Washburn, Captain U. S. N., Light House Board, Treasury Department, Washington, D. C. (33). **B**

Mead, A. D., Brown University, Providence, R. I. (52). **F**

Mead, Chas. S., 217 King Ave., Columbus, Ohio. (52). **F**

*Mead, Elwood, Chief Irrigation Investigations, U. S. Department Agriculture, Washington, D. C. (51). 1902. **D**

Means, James, 196 Beacon St., Boston, Mass. (47).

*Mearns, Maj. Edgar A., M. D., U. S. A., Manila, P. I. (49). 1901. **K**

Medsger, Oliver P., Jacob's Creek, Pa. (50). **G**

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Meehan, S. Mendelson, Germantown, Philadelphia, Pa. (51). **G**

*Mees, Prof. Carl Leo, Rose Polytechnic Institute, Terre Haute, Ind. (24). 1876. **B C**

Meigs, Miss Emily, Lafayette, Ind. (52). **H**

Meigs, Montgomery, U. S. A., U. S. Civil Engineer, Office of D. M. R. Canal, Keokuk, Iowa. (51). **D**

*Mell, P. H., Ph. D., President of Clemson Agricultural College, Clemson College, S. C. (39). 1895. **E G**

Mellen, Edwin D., Manufacturer, 1590 Massachusetts Ave., Cambridge, Mass. (51). **D**

Mellish, Ernest Johnson, M. D., El Paso, Texas. (52). **K**

Mellor, Alfred, President of the Mellor and Rittenhouse Co., 2130 Mt. Vernon St., Philadelphia, Pa. (51).

Mellor, Charles C., 319 Fifth Ave., Pittsburg, Pa. (38).

*Meltzer, S. J., M. D., 166 West 126th St., New York, N. Y. (49). 1901. **K**

*Mendenhall, Charles E., Ph. D., University of Wisconsin, Madison, Wis. (48). 1900. **B**

*Mendenhall, T. C., Worcester, Mass. (20). 1874. **B**

*Mendenhall, Walter Curran, U. S. Geological Survey, Washington, D. C. (52). 1903. **E**

Mengel, Prof. Levi W., Boys High School, Reading, Pa. (52).

Menninger, Charles Frederic, M. D., 1251 Topeka Ave., Topeka, Kan. (50). **F G K**

*Mercer, H. C., Doylestown, Pa. (41). 1893. **H**

Mercer, William Fairfield, Ph. D., Professor of Biology, Ohio University, Athens, Ohio. (50). **F**

*Merriam, Dr. C. Hart, U. S. Department Agriculture, Washington, D. C. (49). 1900. **F**

Merriam, John C., Ph. D., Assistant Professor of Paleontology and Historical Geology, University of California, Berkeley, Cal. (52). **E**

Merrill, Earle Abbott, 26 Cortlandt St., New York, N. Y. (50). **D**

Merrill, Elmer Drew, Insular Bureau of Agriculture, Manila, P. I. (50). **G**

*Merrill, Frederick J. H., Ph. D., New York State Museum, Albany, N. Y. (35). 1887. **E**

Merrill, Joseph Francis, Ph. D., Professor of Physics and Electrical Engineering, University of Utah, Salt Lake City, Utah. (50). **B D**

Merrill, Lucius Herbert, Professor of Biological Chemistry, University of Maine, Orono, Maine. (50). **C**

Merrill, Payson, 111 Broadway, New York, N. Y. (50).

Merrill, Mrs. Winifred Edgerton, Ph. D., 268 State St., Albany, N. Y. (35). **A**

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*Merriman, C. C., 1910 Surf St., Lake View, Chicago, Ill. (29). 1880. F

*Merriman, Mansfield, Lehigh University, So. Bethlehem, Pa. (32). 1885. A D I

*Merritt, Ernest, Cornell University, Ithaca, N. Y. (33). 1890. B

Merrow, Miss Harriet L., Rhode Island College of Agriculture and Mechanic Arts, Kingston, R. I. (44).

Merryweather, George N., 639 Forest Ave., Avondale, Cincinnati, Ohio. (30). F H

Mershon, Ralph D., Consulting Enigneer, 621 Broadway, New York, N. Y. (50). D

*Metcalf, Maynard M., Ph. D., Professor of Biology, The Woman's College, Baltimore, Md. (50). 1901. F

METCALF, ORLANDO, 424 Telephone Building, Pittsburg, Pa. (35). D

*Metcalf, William, 1 Fulton St., Pittsburg, Pa. (33). 1894. D

Metcalf, Wilmot V., Professor of Chemistry and Physics, Carleton College, Northfield, Minn. (50). B C

Metcalfe, Captain Henry, 143 Liberty St., New York, N. Y. (50).

*Metzler, William H., Ph. D., Syracuse University, Syracuse, N. Y. (45). 1899. A

Meyer, Adolf, M. D., Director of Pathological Institute of N. Y. State Hospital, Ward's Island, New York, N. Y. (52). K

Meyer, John Franklin, Morgan Lab. of Physics, Univ. of Penna., Philadelphia, Pa. (51). B

*Meyer, Max, Ph. D., Professor of Psychology, University of Missouri, Columbia, Mo. (49). 1901. H I

*Mezes, Sidney Edward, Professor of Philosophy, University of Texas, Austin, Texas. (50). 1901. I

*Michael, Mrs. Helen Abbott, 35 West Cedar St., Boston, Mass. (33). 1885. C F

*Michelson, Prof. A. A., Chicago University, Chicago, Ill. (26). 1879. B

Miggett, W. L., Supt. of Shops, Univ. of Michigan, Ann Arbor, Mich. (51). D

Miles, Mrs. Cornelia, Principal of Broadway School, 1544 Franklin St., Denver, Colo. (50). G

Miles, Francis T., M. D., 514 Cathedral St., Baltimore, Md. (50). F K

Milham, Willis I., Williams College, Williamstown, Mass. (47). A B

Millar, John M., Escanaba, Mich. (50).

Millard, Charles Sterling, Hammond, La. (51). D

Miller, Armand R., Professor of Chemistry, Manual Training High School, Kansas City, Mo. (50). C

*Miller, Arthur M., Professor of Geology and Zoology, State College, Lexington, Ky. (45). 1898. E

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Miller, Benjamin LeRoy, Johns Hopkins Univ., Baltimore, Md. (50). **E**

*Miller, Prof. Dayton C., Case School of Applied Science, Cleveland, Ohio. (44). 1898. **B**

MILLER, EDGAR G., 213 E. German St., Baltimore, Md. (29). **A E F**

*Miller, Edmund H., Ph. D., Columbia University, New York, N. Y. (50). 1901. **C**

Miller, Emerson R., Professor of Pharmacy. Alabama Polytechnic Institute, Auburn, Alabama. (52). **C**

*Miller, Ephraim, Professor of Mathematics and Astronomy, State University, Lawrence, Kan. (50). 1901. **A**

Miller, Frank E., Professor of Mathematics, Otterbein University, Westerville, Ohio. (44). **A**

Miller, Capt. Frederick Augustus, U. S. N., 2201 Massachusetts Ave., Washington, D. C. (52).

Miller, Fred. J., Editor of "American Machinist," 34 Beech St., E. Orange, N. J. (51). **D**

*Miller, George A., Ph. D., Stanford University, Cal. (46). 1898. **A**

Miller, George N., M. D., 811 Madison Ave., New York, N. Y. (50). **K**

Miller, Gerrit S., U. S. Natl. Museum, Washington, D. C. (51). **F**

Miller, Henry Huntington, Mining and Metallurgical Engineer and Chemist, San Nicholas del Oro, Estado de Guerrero, Mex. (50). **C D E**

Miller, Herbert Stanley, Electrical Engineer, 1025 East Jersey St., Elizabeth, N. J. (50). **D**

Miller, Horace George, M. D., 189 Bowen St., Providence, R. I. (51). **K**

Miller, James Shannon, Professor of Mathematics, Emory and Henry College, Emory, Va. (51). **A B**

Miller, John A., 2500 Park Ave., Cairo, Ill. (22). **D**

Miller, John A., Professor of Mechanics and Astronomy, Indiana University, Bloomington, Ind. (51). **A**

Miller, John Craig, M. D., Professor of Natural Science, Lincoln University, Pa. (50). **B C F K**

Miller, Miss Louise Klein, Dir. Lowthorpe School of Horticulture and Landscape Gardening for Women, Groton, Mass. (50). **I**

Miller, P. Schuyler, Mt. Prospect Laboratory, Flatbush Ave., Brooklyn, N. Y. (46). **C**

Miller, Pleasant T., 816 No. 9th St., Temple, Texas. (50).

*Miller, Prof. William S., University of Wisconsin, Madison, Wis. (42). 1894. **F**

Millis, John, Major of Engineers, U. S. A., U. S. Engineer's Office, Seattle, Wash. (48). **A B D E**

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Mills, Frank Smith, 68 Central St., Andover, Mass. (52). **E**

Mills, James Edward, Instructor in Physical Chemistry, University of North Carolina, Chapel Hill, N. C. (52).

*Mills, Prof. James, Ontario Agricultural College, Guelph, Ontario, Can. (31). 1895. **C I**

*Mills, Prof. Wesley, McGill University, Montreal, Can. (31). 1886. **F H**

*Mills, William C., Orton Hall, Ohio State University, Columbus, Ohio. (48). 1902. **H**

Mills, Wm. Park, Missoula, Mont. (52).

Milne, David, 2030 Walnut St., Philadelphia, Pa. (51).

Minns, Miss S., 14 Louisburg Square, Boston, Mass. (32).

*Minot, Charles Sedgwick, M. D., Harvard Medical School, Boston, Mass. (28). 1880. **F**

Mitchell, Andrew S., Analytical and Consulting Chemist, State Analyst, 220 Greenbush St., Milwaukee Wis. (51). **C**

Mitchell, Edward, 44 Wall St., New York, N. Y. (50).

Mitchell, Henry Bedinger, Tutor in Mathematics, Columbia University, New York, N. Y. (50). **A**

Mitchell, James, Newburgh, N. Y. (50). **A**

Mitchell, John Pearce, Assistant in Chemistry, Stanford University, Cal. (51). **C**

Mitchell, Roland G., 141 Water St., New York, N. Y. (50).

Mitchell, Samuel Alfred, Ph. D., Columbia University, New York, N. Y. (52). **A B**

Mitchell, William Francis, M. D., Lancaster, Mo. (51). **K**

Mixer, Chas. Adam, Civil Engineer, Resident Engineer, Rumford Falls Power Co., Rumford Falls, Maine. (51). **D**

Mixer, Fred. K., 546 Delaware Ave., Buffalo, N. Y. (35). **E**

*Miyake, Kiichi, Ph. D., Botanisches Institut, Universitat zu Bonn, Bonn, Germany. (51). 1903. **G**

Moenkhaus, Wm. J., Bloomington, Ind.¶(51).

Mohler, John F., Professor of Physics, Dickinson College, Carlisle, Pa. (44). **B**

Mohr, Charles, M. D., Professor of Materia Medica and Therapeutics, Hahnemann Medical College and Hospital, Philadelphia, Pa. (51). **K**

Mohr, Louis, M. E., 32 Illinois St., Chicago, Ill. (50). **A D**

*Moler, Geo. S., 106 University Ave., Ithaca, N. Y. (38). 1892.

Molera, E. J., Civil Engineer, 606 Clay St., San Francisco, Cal. (50). **D**

Molitor, David, Civil and Consulting Engineer, 125 Park Ave., Fond du Lac, Wis. (51). **C D**

Molitor, Frederic Albert, Little Rock, Ark. (51). **D**

Momsen, Hart, Chief Clerk, Div. of Agric. Census Office, Washington, D. C. (50). **I**

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Monfort, Wilson F., Marietta College, Marietta, Ohio. (48). C

Monroe, Joseph E., Professor of Physics and Chemistry, Montana State Normal School, Dillon, Mont. (50). B C

*Monroe, Will S., State Normal School, Westfield, Mass. (49). 1901. H

Montgomery, Edmund, M. D., Hemstead, Texas. (50). F K

Montgomery, Edmund B., M. D., 134 North 8th St., Quincy, Ill. (51). K

Montgomery, James H., Meadville, Pa. (50).

Moody, Lucius W., New Haven, Conn. (43). H

Moody, Mrs. Mary B., M. D., Fair Haven Heights, New Haven, Conn. (25). E F

*Moody, Robert O., M. D., Hearst Anatomical Laboratory, San Francisco, Cal. (35). 1892. F

Moody, William Albion, Professor of Mathematics, Bowdoin College, Brunswick, Maine. (50). A

Moore, Mrs. A. H., Stanstead, P. Q., Canada. (32). H

*Moore, Burton E., University of Nebraska, Lincoln, Neb. (41). 1899. B

Moore, Charles James, E. M., P. O. Box 548, Cripple Creek, Colo. (50). D E

*Moore, Clarence B., 1321 Locust St., Philadelphia, Pa. (44). 1897. H

Moore, Eliakim Hastings, Professor of Mathematics, University of Chicago, Chicago, Ill. (52). A

Moore, Ernest Carroll, Ph. D., Instructor in Philosophy, University of California, Berkeley, Cal. (50). I

*Moore, George Thomas, U. S. Dept. Agriculture, Washington, D. C. (49). 1901. G

*Moore, J. W., M. D., Lafayette College, Easton, Pa. (22). 1874. A B D

Moore, Philip North, Geologist and Mining Engineer, 121 Laclede Bldg., St. Louis, Mo. (50). E

Moore, Robert, Civil Engineer, 61 Vandeventer Place, St. Louis, Mo. (51). D

Moore, Stanley H., Manual Training High School, Kansas City, Mo. (50). A D

*Moore, Willis L., Chief of the Weather Bureau, U. S. Dept. Agriculture, Washington, D. C. (44). 1897. B

*Moorehead, Warren K., Curator of Museum, Phillips Academy, Andover, Mass. (38). 1890. H

Morgan, H. A., Professor of Zoology and Entomology, State University, Baton Rouge, La. (50). F

Morgan, Wm. Conger, Ph. D., Instructor in Chemistry, University of California, Berkeley, Cal. (52). C

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Morgan, Wm. F., Short Hills, N. J. (27).
*Morison, George Shattuck, C. E., 49 Wall St., New York, N. Y. (50). 1901. D
*Morley, Prof. Edward W., Adelbert College, Cleveland, Ohio. (18). 1876. B C E
Morrey, Charles B., Ohio State University, Columbus, Ohio. (48). F
Morris, Edward Lyman, Washington High School, Washington, D. C. (52). G
Morris, F. W., Villa Nova, Pa. (51).
Morris, Henry L., 16 Exchange Place, New York, N. Y. (49).
Morris, Newbold, 52 E. 72d St., New York, N. Y. (49).
Morris, Robert C., Clerk of Wyoming Supreme Court, Cheyenne, Wyoming. (51). I
Morris, Robert Tuttle, Professor of Surgery, N. Y. Post Graduate Medical School, 58 W. 56th St., New York, N. Y. (51). K
Morris, Russell Love, Professor of Civil and Mining Engineering, West Virginia State University, Morgantown, W. Va. (50). D
Morrison, Charles Edward, C. E., care B. & M. Co., Butte, Mont. (51). D
Morrison, Gilbert B., 2510 Perry Ave., Kansas City, Mo. (48). B C I
Morrison, Thomas, Manager, Edgar Thomson Steel Works, Braddock, Pa. (51). D
Morse, Albert P., Wellesley, Mass. (50). F
*Morse, E. S., Salem, Mass. (18). 1874. F H
Morse, Fred. W., Prof. of Organic Chemistry, New Hampshire College, Durham, N. H. (51). C
Morse, John Torrey, Jr., 16 Fairfield Street, Back Bay, Boston, Mass. (52).
Morse, Max W., Biological Hall, Ohio State University, Columbus, Ohio. (51). F
Morse, Warner Jackson, Instructor in Botany, University of Vermont, Burlington, Vt. (52). G
Morse, Willard S., Apartado "A," Aguascalientes, Mexico. (50). C D E
Mortensen, Casper, 13 Cedar St., Schenectady, N. Y. (51).
Morton, George L., Room 256, Patent Office, Washington, D. C. (52). B D
*Moseley, Edwin L., High School, Sandusky, Ohio. (34). 1902. G
*Moser, Jefferson F., Commander U. S. N., Commanding U. S. S. "Pensacola," Station D, San Francisco, Cal. (28). 1889. E
*Moses, Prof. Alfred J., Columbia University, New York, N. Y. (49). 1902. E
*Moses, Dr. Thomas F., Worcester Lane, Waltham, Mass. (25). 1883. F H

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Mosman, Alonzo T., U. S. Coast and Geodetic Survey, Washington, D. C. (51). **D**

Motter, Murray Galt, M. D., 1815 Belmont Ave., Washington, D. C. (51). **K**

*Mottier, David M., Ph. D., Professor of Botany, University of Indiana, Bloomington, Ind. (50). 1901. **F G K**

*Moulton, Forest Ray, Ph. D., Instructor in Celestial Mechanics, University of Chicago, Chicago, Ill. (50). 1901. **A**

Mount, William D., M. E., General Superintendent, Mathieson Alkali Works, Saltville, Va. (51). **D**

Mowry, Wm. A., 17 Riverside Square, Hyde Park, Mass. (29). **I**

Moyer, Harold N., M. D., 103 State St., Chicago, Ill. (51). **K**

Moyer, Lycurgus R., C. E., Montevideo, Minn. (50). **D G**

Muckenfuss. A. M., Professor of Chemistry and Physics, University of Arkansas, Fayetteville, Ark. (52). **B C**

Mueller, Edward, Assistant Chemist, N. & W. R.R., Roanoke, Va. (52). **C**

*Muir, John, Martinez, Cal. (22). 1900. **G**

Muir, John J., Manager, Natl. Steel Casting Co., 819 Maryland Ave., Pittsburg, Pa. (51). **D**

Mulford, Miss A. Isabel, Central High School, St. Louis, Mo. (45). **G**

Mullan, W. G. R., President Boston College, Boston, Mass. (52).

*Mulliken, Samuel P., Mass. Inst. Technology, Boston, Mass. (43). 1899.

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*Munson, Welton M., Prof. of Horticulture, The University of Maine, Orono, Me. (41). 1899. **F G**

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*Murdoch, John, Public Library, Boston, Mass. (29). 1886. **F H**

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*Norton, Thomas H., U. S. Consul, Harput, Turkey in Asia. (35). 1887. C
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Posse, Baroness Rose, Posse Gymnasium, 206 Massachusetts Ave., Boston, Mass. (52).

*Post, Charles A., Bayport, Long Island, N. Y. (49). 1901. **A**

Post, Walter A., General Superintendent, Newport News Shipbuilding and Dry-dock Co., Newport News, Va. (51). **D**

Poteat, Wm. L., Wake Forest, N. C. (47). **F**

Potter, Mrs. Henry C., 347 W. 89th St., New York, N. Y. (49).

Potter, Richard B., M. D., West Palm Beach, Fla. (51). **K**

Potter, William Bancroft, Chief Engineer, Ry. Dept. G. E. Co., Schenectady, N. Y. (50). **D**

Potter, William Plumer, Justice Supreme Court of Pennsylvania, 304 St. Clair St., Pittsburg, Pa. (51). **I**

Powel, Colonel de Veaux, 28 Broadway, New York, N. Y. (50).

Powell, James, Mechanical Engineer, 2525 Spring Grove Ave., Cincinnati, Ohio. (51). **D**

Powell, Thomas, M. D., 215–217 Laughlin Bldg., Los Angeles, Cal. (41).

*Power, Frederick B., Ph. D., Director, The Wellcome Research Laboratories, 6 King St., Snow Hill, London, E. C., England. (31). 1887. **C**

*Powers, Le Grand, 3007 13th St. N.W., Washington, D. C. (51). 1902. **I**

Prang, Louis, 45 Centre St., Roxbury, Mass. (29). **D**

Prather, John McClellan, Ph. D., Instructor in Biology, St. Louis, High School, St. Louis, Mo. (52). **F**

Prather, Wm. L., Ph. D., President of the University of Texas, Austin, Texas. (50). **I**

Pratt, Alexander, Jr., Ph. D., 26 Bunnell St., Bridgeport, Conn. (50). **H I**

Pratt, Chas. W., Supt. City Schools, Augusta, Kans. (50). **F**

*Pratt, Joseph Hyde, Ph. D., 74 Broadway, New York, N. Y. (49). 1902. **E**

Préfontaine, Louis A., M. D., 317 Main St., Springfield, Mass. (52). **K**

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Prentiss, Daniel Webster, M. D., 1101 14th St. N. W., Washington, D. C. (50). **F K**

*Prentiss, Robert W., Professor of Mathematics and Astronomy, Rutgers College, New Brunswick, N. J. (40). 1891. **A**

*Prescott, Prof. Albert B., Ann Arbor, Mich. (23). 1875. **C**

Prescott, Samuel Cate, Instructor in Biology, Mass. Inst. Tech., Boston, Mass. (51). **K**

Price, Harvey Lee, Blacksburg, Va. (52). **G**

Price, Robert Henderson, Willow View Farm, Long's Shop, Va. (50). **F G**

Price, Thomas Malcolm, Bureau of Animal Industry, Dept. of Agriculture, Washington, D. C. (50). **C**

Price, Weston A. V., 2238 Euclid Ave., Cleveland, Ohio. (48). **B C**

Prince, J. Dyneley, 15 Lexington Ave., New York, N. Y. (49).

Pritchard, Myron T., 125 School St., Roxbury, Mass. (52). **E I**

Pritchard, Samuel Reynolds, Blacksburg, Va. (47). **D**

Pritchard, William Broaddus, M. D., 105 W. 73d St., New York, N. Y. (51). **K**

*Pritchard, Henry S., President Mass. Inst. Technology, Boston, Mass. (29). 1881. **A**

Probasco, John Buck, M. D., 175 E. Front St., Plainfield, N. J. (51). **K**

*Prosser, Charles S., Ohio State Univ., Columbus, Ohio. (33). 1891. **E F**

Proudfit, Alexander Couper, 40 Wall St., New York, N. Y. (47).

PRUYN, JOHN V. L., JR., Albany, N. Y. (29).

Pryer, Charles, New Rochelle, N. Y. (49).

Puffer, William L., 198 Mt. Vernon St., West Newton, Mass. (50). **D**

Pulsifer, Mrs. C. L. B., Nonquitt, Mass. (33).

*Pulsifer, Wm. H., Nonquitt, Mass. (26). 1879. **A H**

*Pupin, Dr. M. I., Columbia University, New York, N. Y. (44). 1896. **B**

Purdue, Albert Homer, Professor of Geology, University of Arkansas, Fayetteville, Ark. (50). **E**

Puryear, Chas., Professor of Mathematics, Agric. and Mech. College, College Station, Tex. (51). **A**

Pusey, Charles W., M. E., President The Pusey & Jones Co., Wilmington, Del. (51). **D**

Putnam, Chas. P., M. D., 63 Marlborough St., Boston, Mass. (28).

Putnam, Miss Elizabeth D., 2013 Brady St., Davenport, Iowa. (45).

*Putnam, Prof. F. W., Peabody Museum, Cambridge, Mass. (10). 1874. **H**

Putnam, Henry St. Clair, Davenport, Iowa. (47).

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Pyle, Miss Effie B., Principal of High School, Coldwater, Kansas. (51). B C

Quackenbos, John D., M. D., 331 W. 28th St., New York, N. Y. (49).

*Quaintance, A. L., Department of Agriculture, Washington, D. C. (51). 1903. F

Quinn, John James, Warren, Pa. (52).

Quintard, Edward A., Sewanee, Tenn., Supt. of Mines at Batopilas, Mexico. (50). E

Quiroga, Modesto, 127 W. 11th Ave., Columbus, Ohio. (52).

Radin, Paul, 347 East 116th St., New York, N. Y. (52). F K

*Ramaley, Francis, University of Colorado, Boulder, Colo. (45). 1899. G

Ramsey, Rolla Roy, 1002 Lowrey St., Columbia, Mo. (50). B

Rand, C. F., M. D., 1228 15th St. N.W., Washington, D. C. (27). E H

Rand, Herbert Wilbur, Ph. D., Instructor in Zoology, Harvard University, Cambridge, Mass. (51). F

*Rand, Theodore D., Radnor, Pa. (47). 1901. E

Randall, Burton Alexander, M. D., 1717 Locust St., Philadelphia, Pa. (51). K

Randall, John E., Superintendent and Electrical Engineer, Columbia Inc. Lamp Co., St. Louis, Mo. (50). D

Randolph, Beverley S., Mining Supt. Consolidation Coal Co., Frostburg, Md. (50). D E

Randolph, Prof. L. S., Blacksburg, Va. (33). D

*Rane, Frank Wm., New Hampshire Agric. Exper. Station, Durham, N. H. (42). 1900. G

Rankin, Walter M., Professor of Invertebrate Zoology, Princeton University, Princeton, N. J. (51). F

Ransohoff, Joseph, M. D., Cincinnati, Ohio. (51). K

Ransome, Ernest Leslie, Concrete Engineer, Westervelt and 4th Ave., New Brighton, Staten Island, N. Y. (51). D

*Ransome, Frederick Leslie, Ph. D., U. S. Geological Survey, Washington, D. C. (52). 1903. E

Rathbun, Miss Mary Jane, Smithsonian Institution, Washington, D. C. (52). F

*Rathbun, Richard, Smithsonian Institution, Washington, D. C. (40). 1892. F

Rau, Albert George, Principal Moravian Parochial School, 63 Broad St., Bethlehem, Pa. (50). B E

Raymer, George Sharp, E. M., Instructor in Mining, Harvard University, Cambridge, Mass. (50). D E

*Raymond, Rossiter W., 99 John St., New York, N. Y. (15). 1875. E I

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*Raymond, William G., Rensselaer Polytechnic Institute, Troy, N. Y. (44). 1896. **D**

Reber, Samuel, Lieut. Col. U. S. A., Signal Corps, Headquarters of the Army, Washington, D. C. (50). **D**

Rèche, Miss Eugénie M., 31 Howell St., Rochester, N. Y. (41). **E H**

Reckefus, Chas. H., Jr., M. D., 506 N. 6th St., Philadelphia, Pa. (51). **K**

Red, Samuel Clark, M. D., Houston, Texas. (51). **K**

Redding, Allen C., Tybo, Nevada. (39). **C**

Redfield, William C., Commissioner of Public Works, Borough Hall, Brooklyn, N. Y. (44). **D**

Reed, Charles J., 3313 N. 16th St., Philadelphia, Pa. (34). **B C**

Reed, Hugh D., Ithaca, N. Y. (49).

Reed, Hon. James H., Amberson Ave., Pittsburg, Pa. (51). **I**

*Reed, John O., 907 Lincoln Ave., Ann Arbor, Mich. (44). 1898. **B**

*Rees, Prof. John K., Columbia University, New York, N. Y. (26). 1878. **A B E**

Reese, Albert Moore, Ph. D., Syracuse University, Syracuse, N. Y. (52). **F**

*Reese, Charles L., 1020 Jackson St., Wilmington, Del. (39). 1892. **C**

Reese, Herbert M., Mt. Hamilton, Cal. (49). **B**

*Reese, Jacob, 400 Chestnut St., Philadelphia, Pa. (33). 1891. **B D**

*Reid, Harry Fielding, Johns Hopkins University, Baltimore, Md. (36). 1893. **B**

*Reid, Hon. Whitelaw, 451 Madison Ave., New York, N. Y. (50). 1901. **I**

Reifsnyder, Samuel K., High School, Ocean Grove, N. J. (50). **I**

Reighard, Jacob, Prof. of Zoology, Univ. of Michigan, Ann Arbor, Mich. (51). **F**

Reist, Henry G., Mechanical and Electrical Engineer, 5 South Church St., Schenectady, N. Y. (50). **D**

*Remsen, Prof. Ira, President Johns Hopkins University, Baltimore, Md. (22). 1875. **C**

Renninger, John S., M. D., Marshall, Minn. (31). **C F**

Replogle, Mark A., M. E., Hydraulic Engineer, 111 S. Walnut St., Akron, Ohio. (51). **D**

*Reuter, Dr. Ludwig H., 443 East 87th St., New York, N. Y. (46). 1898. **C**

Reynolds, Dudley Sharpe, M. D., 304 W. Chestnut St., Louisville, Ky. (50). **K**

Reynolds, George, P. O. Box B, Salt Lake City, Utah. (44). **H**

*Rhoads, Edward, Haverford College, Haverford, Pa. (47). 1903. **B**

Rhodes, James Ford, Author and Historian, 392 Beacon St., Boston, Mass. (50). **I**

Rice, Calvin Winsor, care Nernst Lamp Co., Pittsburg, Pa. (51). **B D**

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Rice, Edward L., A. B., Ohio Wesleyan University, Delaware, Ohio. (43).

Rice, Edwin Wilbur, Jr., General Electric Co., Schenectady, N. Y. (50). **D**

Rice, John Ainsworth, Mining Engineer, Bland, New Mexico. (50). **D E**

Rice, Martin Everett, Asst. Professor of Physics and Electrical Engineering, University of Kansas, Lawrence, Kans. (50). **B D**

*Rice, Prof. W. North, Wesleyan University, Middletown, Conn. (18). 1874. **E F**

Rich, Michael P., M. D., 50 W. 38th St., New York, N. Y. (40).

Richard, Montrose R., M. D., 77 E. 116th St., New York, N. Y. (51). **K**

Richards, Alfred N., 45 West 60th St., New York, N. Y. (50).

*Richards, Charles B., 237 Edwards St., New Haven, Conn. (33). 1885. **D**

*Richards, Edgar, 341 W. 88th St., New York, N. Y. (31). 1886. **C**

*Richards, Herbert Maule, Ph. D., Instructor in Botany, Barnard College, Columbia University, New York, N. Y. (51). 1902. **G**

*Richards, Prof. Robert H., Mass. Institute of Technology, Boston, Mass. (22). 1875. **D**

*Richards, Mrs. Robert H., Mass. Institute of Technology, Boston, Mass. (23). 1878. **C**

*Richards, Prof. Theodore William, Harvard University, Cambridge, Mass. (47). 1899.

Richardson, Major Charles A., Canandaigua, N. Y. (50). **I**

Richardson, Prof. Charles Henry, Ph. D., Dartmouth College, Hanover, N. H. (47). **E**

Richardson, Dr. Charles Williamson, 1102 L St. N.W., Washington, D. C. (49).

*Richardson, Clifford, Barber Asphalt Paving Co., Long Island City, N. Y. (30). 1884. **C**

*Richardson, Miss Harriet, Smithsonian Institution, Washington, D. C. (49). 1903. **F**

*Richardson, Mark Wyman, M. D., 90 Equitable Building, Boston, Mass. (51). 1903. **K**

Richardson, Wm. D., P. O. Box 185, Fredericksburg, Va. (52). **C F**

Richmond, William Henry, 3425 North Main Ave., Scranton, Pa. (50). **E**

Rickard, T. A., Editor of "The Engineering and Mining Journal," 261 Broadway, New York, N. Y. (50). **D E**

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Ricker, Maurice, Principal of High School, Burlington, Iowa. (50). F

Ricker, N. Clifford, Dean of the College of Engineering, University of Illinois, Urbana, Ill. (50). D

Ricker, Percy Leroy, Department of Agriculture, Washington, D. C. (52). G

Ricketts, Louis D., Consulting Mining Engineer, 99 John St., New York, N. Y. (50). D E

*Ricketts, Prof. Palmer C., 30 Second St., Troy, N. Y. (33). 1887. A D

*Ricketts, Prof. Pierre de Peyster, 104 John St., New York, N. Y. (26). 1880. C D E

Ricketts, Col. R. Bruce, Wilkesbarre, Pa. (33). E

Riddell, John, Mechanical Superintendent, General Electric Co., 1132 State St., Schenectady, N. Y. (51). D

Riddle, Lincoln Ware, Roanoke Ave., Jamaica Plain, Mass. (52). G

Riddle, Lumina C., 160 West Fifth Ave., Columbus, Ohio. (48). G

Riederer, Emil Justus, care Welsbach Light Co., Gloucester City, N. J. (52). C

Ries, Elias E., E. E., 116 Nassau St., New York, N. Y. (33). B D

*Ries, Heinrich, Ph. B., Ithaca, N. Y. (41). 1898. E

Riesman, David, M. D., 326 S. 16th St., Philadelphia, Pa. (51). K

Rietz, Henry Lewis, University of Indianapolis, Indianapolis, Ind. (51). A

*Riggs, Robert Baird, Ph. B., Professor of Chemistry, Trinity College, Hartford, Conn. (50). 1901. C

Riggs, Walter Merritt, Professor of Electrical Engineering, Clemson College, S. C. (50). B D

Riker, Clarence B., Maplewood, N. J. (52). F

Riker, Samuel, 27 E. 69th St., New York, N. Y. (50).

Riley, Isaac Woodbridge, Ph. D., Professor of Philosophy and Pol. Economy, University of New Brunswick, Fredericton, New Brunswick, Canada. (52). H I

Rissmann, Otto, General Manager Cherokee-Lanyon Spelter Co., Iola, Kan. (50). D E

Ritchie, Craig D., Conveyancer, 414 N. 34th St., Philadelphia, Pa. (51).

*Ritter, William Emerson, Associate Professor of Zoology, University of California, Berkeley, Cal. (50). 1901. F

Robb, J. Hampden, 23 Park Ave., New York, N. Y. (50).

Robb, Hunter, M. D., 702 Rose Building, Cleveland, Ohio. (51). K

Robbins, Fred. W., Superintendent of Schools, Bethlehem, Pa. (50). I

Robert, Dr. J. C.. A. and M. College, Agricultural College, Miss. (51).

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Roberts, H. L., Department of Biology, Western Illinois State Normal School, Macomb, Ill. (52.) **F**

Roberts, Miss Jennie B., 231 William St., Port Chester, N. Y. (43).

Roberts, John M., Principal, High School, and Instructor in Science, Marshall, Mo. (50). **F G**

Roberts, Milnor, Professor of Mining and Metallurgy, University of Washington, Seattle, Wash. (50). **D E**

Roberts, Thomas Paschall, Civil Engineer, 361 North Craig St., Pittsburg, Pa. (51). **D**

Roberts, Rev. William C., D. D., LL.D., President of Central University, Danville, Ky. (50).

Roberts, Wm. F., 730 15th St., Washington, D. C. (52). **F I**

Robins, Wm. Littleton, M. D., 1700 13th St., N.W., Washington, D. C. (52). **K**

*Robinson, Benjamin Lincoln, Curator Harvard Herbarium, Cambridge, Mass. (41.) 1893. **G**

Robinson, Charles Dwight, Newburgh, N. Y. (50). **I**

*Robinson, Prof. Franklin C., Bowdoin College, Brunswick, Me. (29). 1889. **C D**

*Robinson, Otis Hall, Professor of Natural Philosophy, University of Rochester, Rochester, N. Y. (23). 1901. **A B**

Robinson, Samuel Adams, M. D., 135 North 22d St., Portland, Oregon. (51). **H I K**

Robinson, Sanford, C. E., E. M., Steeple Rock, New Mexico. (50). **D**

*Robinson, Prof. Stillman W., 1353 Highland St., Columbus, Ohio. (30). 1883. **A B D**

Rochester, DeLancey, M. D., 469 Franklin St., Buffalo, N. Y. (35). **F**

Rockey, A. E., M. D., 778 Flanders St., Portland, Oregon. (51). **K**

*Rockwell, Gen. Alfred P., Manchester, Mass. (10). 1882. **E**

Rockwood, Charles G., 70 South 11th St., Newark, N. J. (36).

*Rockwood, Prof. Charles G., Jr., 34 Bayard Lane, Princeton, N. J. (20). 1874. **A B D E**

Rockwood, Elbert W., Professor of Chemistry and Toxicology, College of Medicine, State University of Iowa, Iowa City, Iowa. (50). **C K**

Rodman, Charles S., M. D., Waterbury, Conn. (51). **K**

Roe, Edward Drake, Jr., Professor of Mathematics, Syracuse University, Syracuse, N. Y. (50). **A**

Roessler, Franz, 39 High St., Perth Amboy, N. J. (39).

Rogers, Miss Anne Fuller, 126 Newbury St., Boston, Mass. (52). **F**

Rogers, Arthur Curtis, M. D., Supt. Minn. School for Feeble-Minded, Faribault, Minn. (51). **K**

Rogers, Edward L., 71 Broadway, New York, N. Y. (50).

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Rogers, John T., M. D., 5th and St. Peter Sts., "Lowry Arcade," St. Paul, Minn. (51). K

*Rolfs, Peter H., Tropical Laboratory U. S. Department Agriculture, Miami, Fla. (41). 1899. G

Rollins, William Herbert, M. D., 250 Marlborough St., Boston, Mass. (50). B K

*Rominger, Dr. Carl, Ann Arbor, Mich. (21). 1879. E

Roney, Wm. R., Mechanical Engineer, 10 Bridge St., New York, N. Y. (51). D

*Root, Hon. Elihu, Secretary of War, Washington, D. C. (50). 1901. I

Rorer, James Birch, 1460 Staughton St., Washington, D. C. (51). G

Rorer, Jonathan T., Ph. D., Central High School, Philadelphia, Pa. (47).

*Rosa, Edward Bennett, National Bureau of Standards, Washington, D. C. (39). 1892. A B

Rose, Joseph Nelson, U. S. National Museum, Washington, D. C. (52). G

Rose, Lewis H., Associate Prof., Chemistry and Physics, Univ. of Arkansas, Fayetteville, Ark. (52). B C

Rosenau, Milton J., M. D., Director Hygienic Laboratory, U. S. Public Health and Marine Hospital Service, Washington, D. C. (51). K

Rosenthal, Edwin, M. D., 517 Pine St., Philadelphia, Pa. (51). K

Ross, Bennett Battle, Professor of Chemistry, Alabama Polytechnic Institute, Auburn, Ala. (45). C

Ross, Denman Waldo, Ph. D., Cambridge, Mass. (29).

Ross, F. G., Civil Engineer, Vandergrift, Pa. (51). D

*Rotch, A. Lawrence, Director of Blue Hill Meteorological Observatory, Hyde Park, Mass. (39). 1896. B

Rotch, T. M., M. D., 197 Commonwealth Ave., Boston, Mass. (51). K

Roth, Filibert, U. S. Dept. of Agriculture, Washington, D. C. (39). F

Rothe, Wm. G., 226 Stuyvesant Ave., Brooklyn, N. Y. (43).

Rothemel, John J., Teacher of Physics, Eastern High School, Washington, D. C. (51). B

Rothschild, Jacob, Hotel Majestic, New York, N. Y. (50).

Rotzell, W. E., M. D., Narberth, Pa. (45). F H

Rowe, Jesse Perry, Head of the Department of Physics and Geology, University of Montana, Missoula, Montana. (52). B E

*Rowlee, W. W., Cornell Univ., Ithaca, N. Y. (41). 1894. G

Roy, Arthur J., C. E., First Assistant, Dudley Observatory, Albany, N. Y. (50). A

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Rucker, Miss Augusta, University of Texas, Austin, Texas. (51).
Ruddick, William H., M. D., So. Boston, Mass. (51). F K
Ruedemann, Rudolf, Ph. D., Paleontologist New York State Museum, 161 Yates St., Albany, N. Y. (52). E F
Ruete, Otto M., Ph. D., Analytical and Consulting Chemist, 721 Bluff St., Dubuque, Iowa. (51). C E
Ruffin, Sterling, M. D., Professor of Theory and Practice of Medicine, Columbian University, 1023 Vermont Ave., Washington, D. C. (52) K
Ruland, Frederick D., M. D., Westport, Conn. (51). B C K
Ruland, M. A., 53 Linden Ave., Flatbush, Brooklyn, N. Y. (43).
Running, Theodore R., Ph. D., Professor of Mathematics and Astronomy, St. Olaf College, Northfield, Minn. (50). A
Runyon, William Henry, Teacher of Science, Lyons Township High School, La Grange, Ill. (50). B F
Rupp, August, A. B., College of City of New York, New York, N. Y. (35).
Ruppersberg, Miss Emma A., 842 South High St., Columbus, Ohio. (48). B
*Rusby, Henry H., M. D., 115 West 68th St., New York, N. Y. (36). 1890. G
Russak, Frank, 19 East 65th St., New York, N. Y. (50). I
Russell, A. H., Lieut. Col. U. S. A., Chief Ordnance Officer, Div. of Philippines, Manila, P. I. (38). D
*Russell, Frank, Ph. D., Howard University, Cambridge, Mass. (45). 1897. H
Russell, Herbert Edwin, Professor of Mathematics, University of Denver, University Park, Colo. (50). A
*Russell, Prof. H. L., University of Wisconsin, Madison, Wis. (41). 1894. G
*Russell, Israel C., University of Michigan, Ann Arbor, Mich. (25). 1882. E
*Russell, James E., Dean of Teachers' College, West 120th St., New York, N. Y. (50). 1901. H I
Russell, John B., Superintendent of Schools, Wheaton, Ill. (51). C
Russell, Hon. John Edwards, Leicester, Mass. (47). I
*Rutter, Frank Roy, Ph. D., U. S. Dept. Agriculture, Washington, D. C. (47). 1900. I
*Ryan, Harris J., Cornell University, Ithaca, N. Y. (38). 1890. B
*Rydberg, Dr. Per Axel, N. Y. Botanical Garden, Bronx Park, New York, N. Y. (49). 1901. G
Rynearson, Edward, Central High School, Pittsburg, Pa. (51). F G
*Sabine, Wallace Clement, 40 Shepard St., Cambridge, Mass. (47). 1900. B

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Sachett, Walter George, Baptist Female University, Raleigh, N. C. (52). **F G**

*Sachs, B., M. D., 21 E. 65th St., New York, N. Y. (49). 1903. **K**

Sackett, Miss Eliza D., Cranford, N. J. (35). **F H**

Sackett, Robert L., C. E., Professor of Applied Mathematics and Astronomy, Earlham College, Richmond, Ind. (50). **A**

Sadtler, Saml. P., Ph. D., LL.D., Consulting Chemist, N. E. corner Tenth and Chestnut Sts., Philadelphia, Pa. (51). **C**

*Saegmuller, G. N., 132 Maryland Ave., S.W., Washington, D. C. (38). 1891. **A B**

Sage, John H., Portland, Conn. (23). **F**

Sager, Fred. Anson, Asst. Professor of Physics, University of Illinois, Urbana, Ill. (50). **B**

*St. John, Prof. Charles E., 125 Elm St., Oberlin, Ohio. (46). 1900. **B**

St. John, Howell W., P. O. Box 913, Hartford, Conn. (49). **I**

Salathé Frederick, Ph. D., General Superintendent, Penna. Oil & Gas Co., Casper, Wyoming. (51). **C**

*Salisbury, Prof. R. D., Chicago University, Chicago, Ill. (37). 1890. **B E**

*Salmon, Daniel E., U. S. Dept. Agriculture, Washington, D. C. (31). 1885. **F**

Sander, Dr. Enno, St. Louis, Mo. (27). **C**

Sanderson, E. Dwight, Prof. of Entomology, Agric. and Mech. College, College Station, Texas. (50). **F**

Sando, Will J., Manager International Steam Pump Co., 120 Liberty St., New York, N. Y. (51). **E**

Sands, Wm. Hupp, M. D., Fairmont, W. Va. (51). **K**

Sanes, K. I., M. D., 1636 5th Ave., Pittsburg, Pa. (51). **K**

*Sanford, E. C., Professor of Psychology, Clark University, Worcester, Mass. (49). 1902. **H I**

*Sanford, Fernando, Professor of Physics, Stanford University, Cal. (50). 1901. **B**

Sardeson, Frederick William, Ph. D., Instructor in Geology, University of Minnesota, Minneapolis, Minn. (50). **E**

Sargent, Miss Annie B., Bellwood, Pa. (52). **F**

Sargent, Ara Nathaniel, M. D., 116 Federal St., Salem, Mass. (51). **K**

*Sargent, Dudley Allen, M. D., Director of the Hemenway Gymnasium, Harvard University, Cambridge, Mass. (47). 1899. **H**

Sargent, Porter Edward, 105 Lexington Ave., Cambridge, Mass. (52). **F**

Satterfield, David Junkin, D. D., President of Scotia Seminary, Concord, N. C. (50). **I**

Satterlee, F. LeRoy, M. D., 8 W. 18th St., New York, N. Y. (50). **K**

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*Saunders, A. P., Ph. D., Hamilton College, Clinton, N. Y. (48). 1900. **C**

*Saunders, Charles E., Ph. D., Experimental Farm, Ottawa, Canada. (41). 1895. **C**

Saunders, Edward W., M. D., 1635 S. Grand Ave., St. Louis, Mo. (51). **K**

Saunders, F. A., Ph. D., Instructor in Physics, Syracuse University, Syracuse, N. Y. (48). **B**

Saunders, Dr. James, Lock Box 147, Orange, Texas. (52).

*Saunders, William, LL.D., F. R. S. C., F. L. S., Canadian Experimental Farms, Ottawa, Canada. (17). 1874. **F**

Saunders, Wm. H., 1407 F St., N.W., Washington, D. C. (52). **I**

Savage, Thomas E., Professor of Geology and Nat. History, Western College, Toledo, Iowa. (52). **E F G**

*Savage, Watson L., M. D., Director of the Gymnasium of Columbia University, Columbia Univ., New York, N. Y. (51). 1902. **K**

*Saville, Marshall H., Amer. Mus. Nat. History, Central Park, New York, N. Y. (39). 1892. **H**

Sawyer, Edward, Civil and Mechanical Engineer, Newton, Mass. (51). **D**

Sayre, Miss Clara B., South Bethlehem, Pa. (50). **E H**

*Sayre, Robert H., South Bethlehem, Pa. (28). 1899. **D**

Scaife, Walter B., care A. W. Elford, Catania, Sicily. (49). **I**

Scaife, William Lucien, 28th St., Pittsburg, Pa. (51). **B D**

*Schaeberle, J. M., 502 Second St., Ann Arbor, Mich. (34). 1886. **A**

Schaeffer, Henri N. F., P. O. Box 676, Manchester, N. H. (46). **C**

Schaffer, Chas., M. D., 1309 Arch St., Philadelphia, Pa. (29). **E F**

Schaffer, Mrs. Mary Townsend Sharpless, 1309 Arch St., Philadelphia, Pa. (38). **E F**

*Schaffner, John H., Ohio State Univ., Columbus, Ohio. (48). 1899. **G**

Scharar, Christian H., 2073 N. Main Ave., Scranton, Pa. (33). **A D E H**

Scheffler, Frederick A., Mechanical and Electrical Engineer, Box 233, Glen Ridge, N. J. (50). **D**

Schenck, Charles C., Ph. D., McGill University, Montreal, Canada. (51). **B**

Schermerhorn, F. Aug., 101 University Place, New York, N. Y. (36).

Schermerhorn, Wm. C., 49 W. 23d St., New York, N. Y. (36).

Schernikow, Ernest, P. O. Box 1191, New York, N. Y. (49).

Schiaffino, Mariano L., Chief Electrical Engineer, "Campania de Luz de Guadalajara," Belen 2, Apartado 260, Guadalajara, Mexico. (50). **D**

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Schiedt, Richard Conrad, Professor of Biology, Franklin and Marshall College, Lancaster, Pa. (50). **F**

Schieffelin, Eugene, 865 Madison Ave., New York, N. Y. (50).

Schieren, Hon. Charles A., 405 Clinton Ave., Brooklyn, N. Y. (43). **C I**

Schiertz, Ferdinand Alfred, Rosario Mines, Ltd., Guadalupe y Calvo, Estado de Chihuahua, Mexico. (50). **D E**

Schiff, Jacob H., P. O. Box 1193, New York, N. Y. (49).

Schirmer, Gustave, 117 E. 35th St., New York, N. Y. (49).

*Schlesinger, Frank, Yerkes' Observatory, Williams Bay, Wis. (51). 1902. **A**

Schlichting, Emil, Analytical Chemist, 61 Hicks St., Brooklyn, N. Y. (50). **C**

*Schlotterbeck, Julius O., Ann Arbor, Mich. (46). 1899. **G**

*Schmeckebier, Lawrence Frederick, Ph. D., U. S. Geol. Survey, Washington, D. C. (50). 1902. **E I**

Schmid, Dr. H. Ernest, White Plains, N. Y. (25).

Schmitt, A. Emil, M. D., 125 East 57th St., The Palermo, New York, N. Y. (50). **K**

Schmitt, Ewald, 311 Florida Ave., N. W., Washington, D. C. (51).

Schobinger, John J., Morgan Park, Ill. (34). **B**

*Schöney, L., M. D., 143 W. 142d St., New York, N. Y. (29). 1900. **F**

Schoonhoven, John J., 34 Second Place, Brooklyn, N. Y. (52). **G**

Schuchert, Charles, U. S. National Museum, Washington, D. C. (52). **E F**

Schuette, J. H., Green Bay, Wis. (34). **B E F**

Schultz, Carl H., 430–444 First Ave., bet. 25th and 26th Sts., New York, N. Y. (29).

Schultz, Louis G., Coast and Geodetic Survey, Magnetic Observatory, Chiltenham, Md. (52). **B**

*Schurman, Jacob Gould, LL.D., President Cornell University, Ithaca, N. Y. (49). 1901.

Schuyler, Philip, Irvington-on-Hudson, N. Y. (49).

Schwab, Dr. Sidney I., 4393 Westminster Place, St. Louis, Mo. (52). **K**

Schwalbe, Carl, M. D., 1002 So. Olive St., Los Angeles, Cal. (51). **K**

*Schwarz, E. A., U. S. Department of Agriculture, Washington, D. C. (29). 1895. **F**

*Schwatt, Isaac Joachim, Assistant Professor of Mathematics, University of Pennsylvania, Philadelphia, Pa. (51). 1902. **A**

*Schweitzer, Prof. Paul, State Univ. of Missouri, Columbia, Mo. (24). 1877. **B C**

Scofield, Carl S., Department of Agriculture, Washington, D. C (52). **G**

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Scott, Prof. Arthur William, St. David's College, Lampeter, S. Wales, England. (46). **A B**

*Scott, Charles F., Westinghouse Electric and Mfg. Co., Pittsburg, Pa. (48). 1900. **B**

Scott, William, 450 4th Ave., Pittsburg, Pa. (50). **I**

Scott, W. M., State Entomologist, Atlanta, Ga. (50). **F**

Scovel, Edward C., Rosebud, S. Dak. (52).

*Scovell, M. A., Director and Chemist, Agricultural Experiment Station, Lexington, Ky. (35). 1887. **C**

Scripture, Arthur M., Principal of High School, New Hartford, N. Y. (51). **D**

*Scripture, E. W., Yale University, New Haven, Conn. (46). 1901. **H**

*Scudder, Samuel H., Cambridge, Mass. (13). 1874. **F**

*Scull, Miss Sarah A., Smethport, Pa. (40). 1895. **H**

Seal, Alfred Newlin, Ph. D., Professor of Chemistry, Girard College, Philadelphia, Pa. (50). **B C**

*Seaman, W. H., Chemist, 1424 11th St. N.W., Washington, D. C. (23). 1874. **C F**

Searing, Anna H., M. D., Escondido, Cal. (41). **G**

Searle, Frederick Edwards, Detroit University School, Detroit, Mich. (52). **B**

*Searle, Prof. George M., St. Thomas College, Catholic University, Washington, D. C. (39). 1891. **A**

Sears, Edward H., Collinsville, Conn. (50). **D I**

Sears, Frederick Edmund, St. Paul's School, Concord, N. H. (47). **C E**

Sears, Dr. Henry Francis, Topsfield, Mass. (50).

*Seashore, Carl E., Univ. of Iowa, Iowa City, Iowa. (49). 1902. **H**

Seawell, Benjamin Lee, Teacher of Biology, State Normal School, Warrensburg, Mo. (50). **F**

Sebert, William F., 48 Strong Place, Brooklyn, N. Y. (41). **A E**

Secor, William Lee, Academia, Ohio. (52). **C**

Sedgwick, Howard M., M. D., 512 Woolner Bldg., Peoria, Illinois. (52). **B C K**

*Sedgwick, William Thompson, Massachusetts Institute of Technology, Boston, Mass. (47). 1898. **F G**

*See, Horace, 1 Broadway, New York, N. Y. (34). 1886. **D**

See, James W., M. E., Opera House, Hamilton, Ohio. (51). **D**

*See, Prof. T. J. J., U. S. Naval Academy, Annapolis, Md. (48). 1901. **A**

*Selby, Augustine Dawson, Agric. Exper. Station, Wooster, Ohio. (44). 1900. **G**

Seligman, Isaac N., Mills Building, New York, N. Y. (49).

Sellers, James Freeman, Prof. of Chemistry, Mercer University, Macon, Ga. (50). **C**

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Sellers, William, 1600 Hamilton St., Philadelphia, Pa. (51).

Sercombe, Parker H., Banker, 1a Calle San Francisco, No. 8, City of Mexico, Mexico. (51). **H**

Serrell, Gen. Edward Wellman, C. E., Forest Ave., West New Brighton, N. Y. (50). **B C D**

Serviss, Garrett P., 8 Middagh St., Brooklyn, N. Y. (52).

Sessinghaus, Gustavus, E. M., 1360 Columbine St., Denver, Colo. (50). **E**

Sever, George F., Electrical Engineer, Broadway and 117th St., New York, N. Y. (49). **B**

Seymour, George Steele, 11 Broadway, New York, N. Y. (51). **B C**

*Seymour, Paul Henry, 245 East 61st St., Chicago, Ill. (44). 1896. **C**

Shafer, John A., Custodian, Carnegie Museum, Pittsburg, Pa. (51). **G**

Shaffner, Samuel C., Supt. Electric Lighting Co., Mobile, Ala. (50). **C D**

Shamel, Archibald D., 1227 Princeton St., N.W., Washington, D. C. (52). **G**

Shantz, Homer LeRoy, Colorado Springs, Colo. (50). **F**

Sharp, Charles Cutler, C. E., E. M.. President Raven Coal and Coke Co., Boomer, W. Va. (50). **D E**

*Sharp, Dr. Clayton H., 722 Highland Ave., Newark, N. J. (45). 1897.

Sharpe, Benjamin F., Greenwich, N. Y. (50). **B**

Sharpe, Richard W., Wilmette, Ill. (51). **F**

Sharples, Philip Price, A. B., 22 Concord Ave., Cambridge, Mass. (47). **C**

*Sharples, Stephen P., 26 Broad St., Boston, Mass. (29). 1884. **C**

*Shattuck, Frederick C., M. D., Professor Clinical Medicine, Harvard Medical College, Boston, Mass. (50). 1901. **F K**

*Shattuck, George Burbank, Johns Hopkins University, Baltimore, Md. (47). 1899. **E**

*Shattuck, Samuel Walker, Professor of Mathematics, University of Illinois, Champaign, Ill. (50). 1902. **A**

Shaw, Dr. Charles Hugh, Professor of Botany, Temple College, Philadelphia, Pa. (52). **G**

Shaw, Edwin C., M. E., 104 Park St., Akron, Ohio. (50). **D**

Shaw, Henry Clay, C. E., Glenshaw, Pa. (51). **D**

Shaw, Henry Lyman, M. D., 19 Commonwealth Ave., Boston, Mass. (51). **K**

*Shaw, Walter Robert, Ph. D., Prof. of Botany and Entomology, Agric. & Mech. College, Stillwater, Okla. Ter. (47). 1902. **F G**

Shaw, Wilson A., Cashier, Merchants and Manuf. National Bank. Norwood Ave., cor. Forbes Ave., Pittsburg, Pa. (50). **I**

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SHEAFER, A. W., Pottsville, Pa. (28).
*Shear, Cornelius L., U. S. Dept. Agriculture, Washington, D. C. (49). 1901. G
Shearer, John Sanford, Instructor in Physics, Cornell University, Ithaca, N. Y. (52). B
Shedd, John C., Prof. of Physics, Colorado Springs, Colo. (50). A B
Shedd, Solon, Professor of Geology and Mining, Agricultural College, Pullman, Wash. (50). E
Sheffield, George St. John, Twin Elms Farm, Attleborough, Mass. (50).
Sheldon, John Lewis, University of Nebraska, Lincoln, Nebraska. (50). G
Sheldon, Mrs. J. M. Arms, 18 W. Cedar St., Boston, Mass. (44). F
*Sheldon, Samuel, Ph. D., Polytechnic Institute, Brooklyn, N. Y. (42). 1894. B
*Shelton, Edward M., 2904 Franklin Ave., Seattle, Wash. (32). 1892. F
SHEPHERD, MISS ELIZABETH, 253 W. 128th St., New York, N. Y. (39).
Shepherd, Frank I., University Station, Los Angeles, Cal. (48). C
Sheppard, Morris, Lawyer and Actuary, Texarkana, Texas. (51).
Sherman, Franklin, Jr., State Entomologist, Raleigh, N. C. (50). F
Sherman, Henry Clapp, Instructor in Analytical Chemistry, Columbia University, New York, N. Y. (51). C
Sherman, Lewis, M. D., 448 Jackson St., Milwaukee, Wis. (50). F K
Sherwood-Dunn, B., M. D., 26 Broadway, New York, N. Y. (51). K
Shidy, Leland P., Coast and Geodetic Survey Office, Washington, D. C. (52). G
Shiland, Andrew, Jr., 262 W. 78th St., New York, N. Y. (50).
Shimek, Bohumil, Professor of Botany, State University, Iowa City, Iowa. (52). F G
*Shimer, Porter W., E. M., Ph. D., Easton, Pa. (38). 1889. C
Shinn, Charles Howard, Head Forest Ranger, Northfork, Cal. (50). F G
Shrader, John Clinton, M. D., LL.D., President Iowa State Board of Health, Iowa City, Iowa. (50). F K
Shropshire, Walter, M. D., Yoakum, Texas. (50). F K
Shultz, Charles S., Hoboken, N. J. (31). F
Shurley, E. L., M. D., 32 Adams Ave., West Detroit, Mich. (51). K
Shute, D. K., M. D., 1101 13th St., N.W., Washington, D. C. (50). F I K
*Sias, Solomon, M. D., Schoharie, N. Y. (10). 1874. K
Sickels, Ivin, M. D., 17 Lexington Ave., New York, N. Y. (50). F K
Siemon, Rudolf, 22 East Jefferson St., Fort Wayne, Ind. (40). A F

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*Sigsbee, Charles D., Captain U. S. N., Navy Department, Washington, D. C. (28). 1882. **D E**

Silloway, Perley Milton, Principal of High School, Lewiston, Montana. (51). **F**

Silver, Elmer E., 221 Columbus Avenue, Boston, Mass. (52).

Silvester, Richard W., President Maryland Agricultural College, College Park, Md. (50). **G**

*Simon, Dr. Wm., 1348 Block St., Baltimore, Md. (29). 1895. **C**

*Simonds, Prof. Frederic W., University of Texas, Austin, Texas. (25). 1888. **E F**

Simpson, Charles Baird, Department of Agriculture, Pretoria, Transvaal, S. Africa. (52). **F G**

Simpson, Friench, Jr., Columbus, Texas. (50). **F H K**

Simpson, Jesse Pickrell, M.D., Palmer, Ill. (51). **K**

Simpson, John Crayke, M. D., Govt. Hospital for the Insane, Washington, D. C. (51). **K**

Sinclair, Alexander Grant, M. D., Memphis Hospital Medical College, Memphis, Tenn. (52). **K**

Singer, George Park, 545 W. Church St., Lock Haven, Pa. (50). **B**

Sirrine, F. Atwood, 110 New York Ave., Jamaica, N. Y. (44). **F**

Skeel, Frank D., M. D., 58 East 25th St., New York, N. Y. (50). **F K**

Skiff, F. J. V., Director, Field Columbian Museum, Chicago, Ill. (43).

*Skinner, Aaron Nichols, U. S. Naval Observatory, Washington, D. C. (40). 1893. **A**

*Skinner, Clarence A., Ph. D., University of Nebraska, Lincoln, Neb. (48). 1903. **B**

Skinner, Clarence Edward, M. D., Physician in charge, The Newhope Hot Air Sanitarium, 67 Grove St., New Haven, Conn. (51). **K**

*Skinner, Henry, M. D., 716 N. 20th St., Philadelphia, Pa. (47). 1902. **F K**

Skinner, James Dudley, 823 E. 14th Ave., Denver, Colo. (50). **B D**

Slade, Elisha, Somerset, Mass. (29). **F**

Slagle, Robert Lincoln, Ph. D., President, State School of Mines, Rapid City, S. D. (50). **C E**

*Slichter, Charles S., Professor of Applied Mathematics, University of Wisconsin, Madison, Wis. (51). 1902. **A**

*Slingerland, Mark Vernon, Assistant Professor of Economic Entomology, Cornell University, Ithaca, N. Y. (50). 1901. **F**

Slipher, V. M., Lowell Observatory, Flagstaff, Arizona. (52). **A**

Slocum, Chas. E., M. D., Defiance, Ohio. (34). **F G H**

Slocum, Frederick, Ph. D., Ladd Observatory, Providence, R. I. (47).

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Slonaker, James Rollin, University of Chicago, Chicago, Ill. (49). **F**

*Slosson, Edwin E., Professor of Chemistry, University of Wyoming, Laramie, Wyoming. (50). 1901. **C**

*Small, John Kunkel, N. Y. Botanical Garden, Bronx Park, New York, N. Y. (44). 1902. **G**

Smallwood, Miss Mabel Elizabeth, 430 West Adams St., Chicago, Ill. (52). **F**

Smallwood, Martin, Syracuse University, Syracuse, N. Y. (50). **E F**

Smillie, Thomas W., U. S. National Museum, Washington, D. C. (40). **F**

*Smith, Prof. Albert W., Case School of Applied Science, Cleveland, Ohio. (47). 1900. **C**

*Smith, Alexander, Ph. D., University of Chicago, Chicago, Ill. (40). 1892. **C**

Smith, Allen J., M. D., School of Medicine, University of Texas, Galveston, Tex. (47). **H**

Smith, Mrs. Annie Morrill, 78 Orange St., Brooklyn, N. Y. (49). **G**

Smith, Arthur, 152 Broadway, New York, N. Y. (50). **G**

Smith, Arthur George, Assistant Professor of Mathematics, State University, Iowa City, Iowa. (50). **A**

Smith, Arthur Whitmore, 52 Chestnut St., Andover, Mass. (44). **B**

*Smith, Charles J., 35 Adelbert St., Cleveland, Ohio. (32). 1885. **A B**

*Smith, Prof. Edgar F., University of Pennsylvania, Philadelphia, Pa. (33). 1891. **C**

*Smith, Erastus G., Ph. D., Director Beloit Sanitary Laboratory, Beloit, Wis. (34). 1887. **C**

*Smith, Ernest Ellsworth, 26 East 29th St., New York, N. Y. (43). 1898. **F K**

*Smith, Erwin F., U. S. Dept. Agriculture, Washington, D. C. (34). 1890. **G**

Smith, Eugene, C. E., 317 Washington St., Hoboken, N. J. (50). **D**

*Smith, Prof. Eugene Allen, State Geologist, University, Ala. (20). 1877. **C E**

Smith, E. R., M. D., Toledo, Iowa. (51). **K**

Smith, Felix Ezell, Superintendent of Schools, Victoria, Texas. (51). **F G**

*Smith, Frank, University of Illinois, Urbana, Ill. (49). 1900. **F**

Smith, George Otis, U. S. Geological Survey, Washington, D. C. (52). **E**

*Smith, Harlan I., Amer. Mus. Nat. History, Central Park, New York, N. Y. (41). 1896. **H**

*Smith, Prof. Harold B., Polytechnic Institute, Worcester, Mass. (43). 1898. **D**

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Smith, Harvey F., Attorney at Law, Clarksburg, W. Va. (50). I

Smith, Herbert S. S., Professor of Applied Mechanics, Princeton University, Princeton, N. J. (29). D

Smith, Hugh M., U. S. Fish Commission, Washington, D. C. (52). F

Smith, Miss J. Angelina, Hopedale, Mass. (45). E

Smith, J. C., 131 Carondelet St., New Orleans, La. (48).

Smith, James Edward, Superintendent of Schools, Llano, Texas. (52). A

Smith, Prof. J. F., President Commercial College, Dallas, Texas. (52). I

Smith, James Hervey, 217 North Central Ave., Chicago, Ill. (40).

*Smith Jared G., Hawaiian Experiment Station, Honolulu, T. H. (47). 1901. G

SMITH, Miss JENNIE M., 40 Library Place, Allegheny, Pa. (50). A F

*Smith, John B., Ph. D., Rutgers College, New Brunswick, N. J. (32). 1884. F

Smith, Joseph R., M. D., LL.D., Colonel and Assistant Surgeon General, U. S. A., 2300 De Lancey St., Philadelphia, Pa. (43).

Smith, Lee H., M. D., 663 Main St., Buffalo, N. Y. (51). H

SMITH, Miss MATILDA H., 40 Library Place, Allegheny, Pa. (50). A

Smith, Matthew Mann, M. D., Austin, Texas. (50). F K

Smith, Middleton, 1616 19th St., N.W., Washington, D. C. (52).

Smith, Philip Sidney, 54 Concord Ave., Cambridge, Mass. (47). E

*SMITH, Q. CINCINNATUS, M. D., 617 Colorado St., Austin, Texas. (26). 1881. K

Smith, Thomas A., Professor of Mathematics and Physics, Beloit Collcge, Beloit, Wis. (50). A B

Smith, T. Guilford, Civil Engineer, Regent University, State of New York, Buffalo, N. Y. (50). D

Smith, Warren Rufus, Instructor in Chemistry, Lewis Institute, Chicago, Ill. (52). C

*Smith, William Benjamin, Professor of Mathematics, Tulane University, New Orleans, La. (50). 1901. A

Smith, Wm. Lincoln, Consulting Electrical and Illuminating Engineer, Concord, Mass. (47). D

Smith, William Sidney Tangier, Ph. D., U. S. Geological Survey, Washington, D. C. (50). E

Smith, William T., M. D., Prof. of Physiology and Dean of Dartmouth Medical School, Hanover, N. H. (51). K

*Smock, Prof. John Conover, State Geologist, Trenton, N. J. (23). 1879. E

Smoot, Edgar Kenneth, Engineer and Contractor, 1511 Rhode Island Ave., N.W., Washington, D. C. (51). D

Smyth, Bernard Bryan, Librarian and Secretary of the Academy of Science, Topeka, Kansas. (51). G

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*Smyth, C. H., Jr., Clinton, N. Y. (38). 1894. E
*Sneath, E. Hershey, Professor of Philosophy, Yale University, New Haven, Conn. (51). 1902. H
Snedaker, James Angus, Mining Engineer, 721–722 Equitable Bldg., Denver, Colo. (50). D
Snelling, Charles Mercer, Junior Professor of Mathematics, University of Georgia, Athens, Ga. (50). A
Sneve, Haldor, M. D., Lowry Arcade, St. Paul, Minn. (51). K
Snook, H. Clyde, Professor of Physics and Chemistry, Allegheny College, Meadville, Pa. (50). B C
Snow, Charles Carleton, 1737 9th St., N.W., Washington, D. C (52).
*Snow, Benjamin W., 518 Wisconsin Ave., Madison, Wis. (35). 1889. B
*Snow, F. H., LL. D., Professor of Natural History, University of Kansas, Lawrence, Kan. (29). 1881. E F
Snyder, Fred. D., M. D., 10 Center St., Ashtabula, Ohio. (51). E F H
*Snyder, Prof. Harry, 2090 Dooley Ave., Saint Anthony Park, Minn. (44). 1897. C
Snyder, Miss Lillian, Lafayette, Ind. (47). G
*Snyder, Prof. Monroe B., Philadelphia Astronomical Observatory, Philadelphia, Pa. (24). 1882. A B
Snyder, Nathaniel Marion, Electrical Engineer, Gering, Neb. (50). B D
Snyder, William E., M. E., 510 E. North Ave., Allegheny, Pa. (51). D
Snyder, Zachariah Xenophon, President State Normal School, Greeley, Colo. (50). F
Sollmann, Torald, M. D., Assistant Professor of Pharmacology, Western Reserve Med. College, Cleveland, Ohio. (52). K
Soper, George A., Ph. D., 29 Broadway, New York, N. Y. (46). C
*Soule, R. H., 917 Seventh Ave., New York, N. Y. (33). 1886. D
*Soule, William, Ph. D., Mount Union Coll., Alliance, Ohio. (33). 1899. B C E
Southall, James P. C., Professor of Physics, Alabama Polytechnic Institute, Auburn, Ala. (51). B
Souvielle, Mathieu, M. D., Box 355, Jacksonville, Fla. (36). B E F
Souvielle, Mrs. Mathieu, Box 355, Jacksonville, Fla. (24). A B F
Sowers, David Wood, Supt. Buffalo Branch N. Y. Elec. Veh. Trans. Co., 179 N. Pearl St., Buffalo, N. Y. (51). D
*Spalding, Frederick P., Professor of Civil Engineering, Univ. of Missouri, Columbia, Mo. (46). 1899. D
*Spalding, Volney M., Ph. D., Professor of Botany, University of Michigan, Ann Arbor, Mich. (51). 1902. G

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Spangler, Harry Allen, M. D., Carlisle, Pa. (51). K

Spaulding, Edward G., Ph. D., College of the City of New York, New York, N. Y. (50). I

Spayd, Henry Howard, Principal of Schools, Minersville, Pa. (52). B E K

Spear, Gen. Ellis, 1601 Laurel Ave., Mt. Pleasant, D. C. (52). D

Spencer, Arthur Coe, U. S. Geological Survey, Washington, D. C. (52). E

Spencer, John Campbell, M. D., Medical Department, University of California, San Francisco, Cal. (50). F K

*Spencer, Prof. J. William, 152 Bloor St., Toronto, Canada. (28). 1882. E

*Spenzer, John G., M. D., 116 Rose Bldg., Cleveland, Ohio. (37). 1895. C

Sperry, Elmer A., Electrical Engineer, 366–388 Massachusetts Ave., Buffalo, N. Y. (51). D

*Speyers, Clarence Livingston, Professor of Physical Chemistry, Rutgers College, New Brunswick, N. J. (50). 1901. C

Spicer, Walter E., M. D., 312 West 51st St., New York, N. Y. (51). K

Spiegelhalter, Dr. Joseph, 2166 Lafayette Ave., St. Louis, Mo. (47). E

Spillman, Wm. Jasper, U. S. Department of Agriculture, Washington, D. C. (52). G

*Spinney, L. B., Iowa State College, Ames, Iowa. (42). 1897. B

Spofford, Paul N., P. O. Box 1667, New York, N. Y. (36).

Spohn, Arthur Edward, M. D., Corpus Christi, Texas. (50). F K

Sprague, C. C., 1900 Locust St., St. Louis, Mo. (50).

Sprague, C. H., Malden, Mass. (29).

Sprigg, Wm. Mercer, M. D., 1015 16th St., N.W., Washington, D. C. (52). K

*Springer, Dr. Alfred, 312 E. 2d St., Cincinnati, Ohio. (24). 1880. C

Springsteen, Harry W., Johns Hopkins Univ., Baltimore, Md. (49). A B

Squibb, Charles F., Bernardsville, N. J. (43).

Squibb, Edward Hamilton, M. D., 148 Columbia Heights, Brooklyn, N. Y. (41). F K

Stackpole, Morrill D., Genl. Supt. Overland Gold Mining Co., Sunshine, Utah. (50). E

Stahley, George D., M. D., Gettsyburg, Pa. (47). F G

Stair, Leslie Dalrymple, 1062 E. Madison Ave., Cleveland, Ohio. (52). G

Stanley, William, Great Barrington, Mass. (50).

Stanley-Brown, Joseph, 128 Broadway, New York, N. Y. (52).

Stanton, Frank McMillan, E. M., Agent of Atlantic, Baltic and Central Mining Co's Atlantic Mine, Mich. (51). D E

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Stanton, John R., 11 and 13 William St., New York, N. Y. (49).
Stanton, Robert Brewster, Civil and Mining Engineer, 66 Broadway, New York, N. Y. (51). **D**
*Stanton, Timothy W., Paleontologist, U. S. Geological Survey, Washington, D. C. (50). 1902. **E**
Starks, Edwin Chapin, Curator and Instructor, Department of Zoology, Stanford University, Cal. (50). **F**
Starr, Elmer G., M. D., 523 Delaware Ave., Buffalo, N. Y. (50). **F K**
*Starr, Frederick, Ph. D., University of Chicago, Chicago, Ill. (36). 1892. **E H**
*Starr, M. Allen, M. D., 5 West 54th St., New York, N. Y. (50). 1901. **K**
Starrett, M. G., 349 W. 85th St., New York, N. Y. (49).
Stauffer, Rev. Thomas F., 200 11th St., Sioux City, Iowa. (51). **I**
*Stearns, Robert E. C., Ph. D., 1025 East Eighteenth St., Los Angeles, Cal. (18). 1874. **F**
Stearns, Theron C., M. D., Consulting Chemist, 44 Montgomery St., Jersey City, N. J. (49).
Stearns, Thomas B., Mining Engineer, Denver, Colo. (50). **D E**
Stebbins, Miss Fannie A., 480 Union St., Springfield, Mass. (44). **F G**
Steensland, Halbert Severin, M. D., College of Medicine, Syracuse University, Syracuse, N. Y. (50). **F K**
Steer, Justin, M. D., Medical Department, Washington University, St. Louis, Mo. (50). **F K**
*Steiger, George, Chemical Laboratory, U. S. Geol. Survey, Washington, D. C. (40). 1901. **B C E**
Stein, Dr. Simon G., Muscatine, Iowa. (43).
Steinbach, Lewis W., M. D., 1309 N. Broad St., Philadelphia, Pa. (51). **K**
Steiner, Roland, Ph. D., Grovetown, Ga. (48). **H**
*Steinmetz, Charles Proteus, General Electric Co., Schenectady, N. Y. (40). 1895. **B**
Steinwand, O. W., M. D., Selma, Cal. (52). **K**
*Stejneger, Leonhard, Curator of Dept. of Reptiles, U. S. National Museum, Washington, D. C. (40). 1892. **F**
Stellwagen, Thos. C., M. D., Prof. Physiology, Philadelphia Dental College, 1328 Chestnut St., Philadelphia, Pa. (51). **K**
Stephens, Henry Matthew, Professor of Biology, Dickinson College, Carlisle, Pa. (50). **F G**
*Stephens, W. Hudson, Lowville, N. Y. (18). 1874. **E H**
Stern, Philip Kossuth, Consulting Mechanical and Electrical Engineer, 130 Fulton St., New York, N. Y. (50). **B D**
Sternberg, Charles Hazelius, Lawrence, Kansas (50). **E F**

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*Sternberg, Gen. George M., M. D., LL. D., U. S. A., War Department, Washington, D. C. (24). 1880. F

Sterne, Albert E., M. D., "Norways," Indianapolis, Ind. (51). K

Stetson, George R., 1441 Mass. Ave. N.W., Washington, D. C. (49). H I

Steuart, Arthur, 951 Equitable Building, Baltimore, Md. (48). C

Stevens, Cyrus Lee, M. D., Secy. of the Medical Society of the State of Pa., Athens, Pa. (51). K

Stevens, Edward Lawrence, Associate City Superintendent o Schools, 59th St. and Park Ave., New York, N. Y. (52).

*Stevens, Frank L., Ph. D., Prof. of Biology, College of Agric. and Mech. Arts, West Raleigh, N. C. (44). 1899. G

Stevens, Frederick W., Department of Physics, Lake Forest University, Lake Forest, Ill. (50). B

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*Stevens, James S., The University of Maine, Orono, Me. (48). 1900. B

*Stevens, Prof. W. LeConte, Washington and Lee University, Lexington, Va. (29). 1882. B

Stevenson, Francis L., 79 Lincoln Ave., Chicago, Ill. (47). D

*Stevenson, Prof. John J., University Heights, New York, N. Y. (36). 1888. E

*Stevenson, Mrs. Matilda C., Bureau of American Ethnology, Washington, D. C. (41). 1893. H

Stevenson, Robert, Consulting Civil and Mining Engineer, P. O. Box 2214, San Francisco, Cal. (50). D E

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Stewart, D. D., M. D., 1429 Walnut St., Philadelphia, Pa. (51). K

Stewart, Francis Laird, Murrysville, Pa. (51). G

*Stewart, Fred. Carlton, Botanist, N. Y. Agric. Exper. Station, Geneva, N. Y. (44). 1901. G

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Stewart, James Henry, Director of W. Va. Agric. Exper. Station, Morgantown, W. Va. (50). E

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Stewart, Ralph Chambers, 1031 Spruce St., Philadelphia, Pa. (51).

Stewart, Robert W., M. D., The Oritz, Cincinnati, Ohio. (51). K

Stickney, Gardner P., care Oliver C. Fuller & Co., Milwaukee, Wis. (44). 1901. H

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Still, George A., 1428 Locust St., Des Moines, Iowa. (50). C

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*Stone, Prof. George E., Mass. Agricultural College, Amherst, Mass. (48). 1902. G

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Stringham, Irving, Professor of Mathematics, University of California, Berkeley, Cal. (51). A I

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Stump, James A., Instructor in Physics, Agricultural College, Fort Collins, Colo. (50). B

*Sturgis, Wm. C., 28 E. Columbia St., Colorado Springs, Colo. (40). 1892. G

Sullivan, J. A., 308 Main St., Malden, Mass. (27). A

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Summers, Joseph, Principal High School, Trenton, Mo. (51). B

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Surface, Harvey Adam, Professor of Zoology, Penna. State College, State College, Pa. (50). F

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Thornber, John J., Botanist, Agr. Exper. Station, Tucson, Arizona. (50). G

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*Thorndike, E. L., Ph. D., Adjunct Prof. of Genetic Psychology, Columbia Univ., New York, N. Y. (49). 1901. H I K

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*Thruston, R. C. Ballard, Ballard & Ballard Co., Louisville, Ky. (36). 1896. E
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Tiffany, L. C., 27 E. 72d St., New York, N. Y. (50).
*Tight, Professor William George, President University New Mexico, Albuquerque, N. M. (39). 1900. E
Tilley, Charles Edward, Teacher of Physics and Chemistry, Hope Street High School, Providence, R. I. (50). B C
Tilson, P. S., Associate Professor of Chemistry, A. and M. College, College Station, Tex. (50). C
Tilton, John Littlefield, Simpson College, Indianola, Iowa. (50). E
Tingle, J. Bishop, Illinois College, Jacksonville, Ill. (50). C
*Titchener, E. B., Professor of Psychology, Cornell University, Ithaca, N. Y. (51). 1902. K
*Tittmann, Otto H., Supt. U. S. C. and G. Survey, Washington, D. C. (24). 1888. A
Titus, E., Jr., 10 E. 70th St., New York, N. Y. (50).
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Todd, Albert M., Kalamazoo, Mich. (37). C
*Todd, Prof. David P., Director Lawrence Observatory, Amherst College, Amherst, Mass. (27). 1881. A B D
*Todd, Prof. James E., State Univ., Vermillion, S. Dak. (22). 1886. E F
Todd, J. H., M. D., Christmas Knoll, Wooster, Ohio. (48).
Todd, William J., M. D., Mt. Washington, Baltimore, Md. (51). K
Tolman, Rev. Marcus Alden, 123 S. High St., Bethlehem, Pa. (50). I
Tompkins, Stonewall, M. E., 1013 Franklin Ave., Houston, Tex. (51). D
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Toothe, William, Madison, N. J. (49).
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Troth, Alonzo P., Principal of High School, Leadville, Colo. (50). F

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*Trowbridge, Charles Christopher, Tutor in Physics, Columbia University, New York, N. Y. (50). 1901. B

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Tucker, William Albert, Le Sueur, Minn. (51). G

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Underwood, William Lyman, Lecturer on Biology, Mass. Institute of Technology, Boston, Mass. (51). **F K**

*Updegraff, Milton, U. S. Naval Academy, Annapolis, Md. (40). 1895. **A**

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Upton, George B., Milton, Mass. (50).

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*Van Dyck, Prof. Francis Cuyler, Rutgers College, New Brunswick, N. J. (28). 1882. B C F

Van Dyck, William Van Bergen, Cronly, N. C. (50). D

Van Gelder, Arthur P., Superintendent Climax Powder Mfg. Co., Emporium, Pa. (50).

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Wade, John W., M. D., 318 N. Second St., Millville, N. J. (51). **K**

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WADSWORTH, F. L. O., Dir. Allegheny Observatory, Western University of Pennsylvania, Allegheny, Pa. (52). **A**

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Wadsworth, Herbert, 1801 Massachusetts Ave., N.W., Washington, D. C. (52). **H I**

*Wadsworth, M. Edw., Professor of Mining and Geology, Penna. State Coll., State College, Pa. (23). 1874. **E**

Wadsworth, William Austin, Geneseo, N. Y. (50). **G**

*Wagner, Frank C., Rose Polytechnic Institute, Terre Haute Ind. (34). 1897. **D**

Wagner, George, 636 E. University Ave., Ann Arbor, Mich. (46). **F G**

Wagner, Samuel, President of Wagner Free Institute of Science, Greenbank Farm, Westchester, Pa. (51).

Waidner, Charles W., Nat. Bureau of Standards, Washington, D. C. (52). **B**

Wainwright, Jacob T., Metallurgical Engineer, P. O. Box 774, Chicago, Ill. (51). **B D E**

Wainwright, John William, M. D., 177 W. 83d St., New York, N. Y. (51). **K**

Wait, Charles Edmund, Professor of Chemistry, Univ. of Tennessee, Knoxville, Tenn. (51). **C**

Waite, Frederick Clayton, Ph. D., Asst. Prof. of Histology and Embryology, Medical Department, Western Reserve Univ., Cleveland, Ohio. (50). **F K**

*Waite, M. B., U. S. Dept. Agriculture, Washington, D. C. (37). 1893. **G**

*Walcott, Charles D., Director U. S. Geol. Survey, Washington, D. C. (25). 1882. **E F**

*Waldo, Prof. Clarence A., Purdue University, Lafayette, Ind. (37). 1889. **A**

*Waldo, Leonard, 640 West 8th St., Plainfield, N. J. (28). 1880. **A**

Wales, Charles M., M. E., 11 Broadway, New York, N. Y. (51). **D**

Wales, Salem H., 25 E. 55th St., New York, N. Y. (36).

Walker, Albert Mynard, U. S. Geological Survey, Washington, D. C. (52). **E**

Walker, Byron Edmund, Toronto, Can. (38). **E**

Walker, Charles R., M. D., Concord, N. H. (50). **K**

Walker, Prof. Ernest, University of Arkansas. Fayetteville, Ark. (52).

Walker, E. W., Superintendent State School for the Deaf, Delavan. Wis. (52). **I**

Walker, George C., Room 367, Rookery Building, Chicago, Ill. (17).

Walker, James, 49 Maiden Lane, New York, N. Y. (43).

Walker, John A., E. M., 260 Montgomery St., Jersey City, N. J. (50). **C D E I**

Walker, R. M., 713 Prudential Bldg., Atlanta, Ga. (52). **D**

Walker, T. B., Pres., Minneapolis City Library Board, 803 Hennepin Ave., Minneapolis, Minn. (51).

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Waller, Coleman Bailey, Clemson College, S. C. (51). **A B C**

*Waller, E., 7 Franklin Place, Morristown, N. J. (23). 1874.

Walls, John Abbet, 990a Sherbrooke St., Montreal, Can. (51). **D**

Walpole, Frederick A., U. S. Department of Agriculture, Washington, D. C. (52). **G**

Walsh, James J., M. D., LL.D., Lecturer on Medicine, New York Polyclinic, 1973 Seventh Ave., New York, N. Y. (51). **K**

Walsh, Thomas F., Le Roy and Phelps Place, Washington, D. C. (49). **D**

Walter, Miss Emma, 109 North 16th St., Philadelphia, Pa. (50). **E**

Walter, Rudolph J., Mining Engineer and Metallurgist, 1452 Blake St., Denver, Colo. (50). **D E**

Walter, W. J., 115 W. 57th St., New York, N. Y. (50).

Walters, John Daniel, Prof. of Industrial Art., Kan. State Agricultural College, Manhattan, Kan. (51). **D**

Walton, John C., M. D., Reidsville, N. C. (51). **K**

*Wanner, Atreus, York, Pa. (36). 1890. **H**

Wantland, C. E., U. P. R.R. Co., 1025 17th St., Denver, Colo. (50). **E**

Ward, Delancey W., 163 Madison Ave., Flushing, N. Y. (51). **C**

Ward, Frank A., 16–26 College Ave., Rochester, N. Y. (40).

*Ward, Henry A., 620 Division St., Chicago, Ill. (13). 1875. **E F H**

*Ward, Dr. Henry B., Dean of Medical Faculty, University of Nebraska, Lincoln, Neb. (48). 1899. **F**

Ward, Henry L., Secretary Board Trustees, Public Museum, Milwaukee, Wis. (51). **E**

Ward, J. Langdon, 120 Broadway, New York, N. Y. (29). **I**

*Ward, Lester F., U. S. Geol. Survey, Washington, D. C. (26). 1879. **E G**

Ward, Louis Clinton, Teacher of Geology and Geography, Bloomington, Ind. (51). **E**

Ward, Milan Lester, Professor of Mathematics and Astronomy, Ottawa Univ., Ottawa, Kansas. (50). **A**

*Ward, Robert De C., Harvard Univ., Cambridge, Mass. (47). 1902 **E.**

*Ward, Dr. R. H., 53 Fourth St., Troy, N. Y. (17). 1874. **F C**

Ward, Willard Parker, Ph. D., Mining Engineer, 164 W. 58th St., New York, N. Y. (50). **D E**

Warden, Albert W., M. D., 325 Fulton St., Weehawken, N. J. (51). **K**

Warder, Charles Barclay, M. D., 1715 Walnut St., Philadelphia, Pa. (51). **K**

*Warder, Prof. Robert B., Howard University, Washington, D. C. (19). 1881. **B C**

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*Ware, Wm. R., School of Architecture, Columbia University, New York, N. Y. (36). 1901. **D**

*Warington, Robert, F. R. S., Rothamsted, Harpenden, England. (40). 1899. **C**

*Warner, James D., 463 E. 26th St., Flatbush, Brooklyn, N. Y. (18). 1874. **A B**

*Warner, Worcester R., 1722 Euclid Ave., Cleveland, Ohio. (33). 1888. **A B D**

Warren, Charles H., Ph. D., Instructor in Mineralogy, Mass. Inst. Tech., Boston, Mass. (52). **E**

Warren, Geo. F., Jr., Howard, Neb. (52).

Warren, Rt. Rev. Henry White, Bishop M. E. Church, University Park, Colo. (50). **A**

*Warren, Prof. Howard C., Princeton Univ., Princeton, N. J. (46). 1901. **H K**

*Warren, Joseph W., M. D., Bryn Mawr. Pa. (31). 1886. **F**

*Warren, S. Edward, Newton, Mass. (17). 1875. **A I**

Warren, William R., 68 William St., New York, N. Y. (49).

Warrington, James N., 1711 South Hope St., Los Angeles, Cal. (34). **A B D**

Washburn, Frederic Leonard, State Entomologist, University of Minnesota, Minneapolis, Minn. (51). **F**

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*Washington, Dr. Henry S., Locust, N. J. (44). 1897. **E**

Waterhouse, James Smartt, Professor of Chemistry and Natural Science, Cumberland University, Lebanon, Tenn. (50). **C F G**

Waters, C. E., Assistant in Chemistry, Johns Hopkins University, Baltimore, Md. (52). **C**

Watson, Benj. Marston, Bussey Institution, Jamaica Plain, Mass. (50).

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Watson, Frank Elbert, 832 Main St., Springfield, Mass. (51). **F**

Watson, Irving Allison, M. D., Sec'y State Board of Health, Concord, N. H. (52). **K**

Watson, Professor Joseph Ralph, Ohio Agr. Exp. Sta., Wooster, Ohio. (50). **G**

Watson, Thomas A., Weymouth, Mass. (42). **E**

*Watson, Prof. Wm., 107 Marlborough St., Boston, Mass. (12). 1884. **A**

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*Wead, Charles K., U. S. Patent Office, Washington, D. C. (47). 1898. **B**

Weatherly, Ulysses Grant, Professor of Economics, University of Indiana, Bloomington, Ind. (50). **I**

Weaver, Edwin Oscar, Professor of Physics and Biology, Wittenberg College, Springfield, Ohio. (51). **B F G**

Weaver, Gerrit E. Hambleton, 916 Farragut Terrace, West Philadelphia, Pa. (38). **G I**

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*Webb, Prof. J. Burkitt, Stevens Institute, Hoboken, N. J. (31). 1883. **A B D**

*Webber, Herbert J., U. S. Dept. Agriculture, Washington, D. C. (47). 1900. **G**

*Weber, Prof. Henry A., Ohio State Univ., Columbus, Ohio. (35). 1888. **C**

Webster, Albert Lowry, C. E., Consulting Civil and Sanitary Engineer, 112 E. 40th St., New York, N. Y. (50). **C D**

*Webster, Prof. Arthur Gordon, Clark University, Worcester, Mass. (47). 1898. **A B**

Webster, Edgar H., Professor of Physical Science, Atlanta University, Altanta, Ga. (50). **B**

*Webster, Prof. F. M., 806 W. Springfield Ave., Urbana, Ill. (35). 1890. **F**

Webster, Frederic S., Carnegie Museum, Pittsburg, Pa. (51). **E F H**

Weed, Alfred, care Nicholson File Co., Providence, R. I. (51). **D**

*Weed, Clarence M., Ph. D., Durham, N. H. (38). 1890. **F**

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*Weed, W. H., U. S. Geological Survey, Washington, D. C. (52). 1903. **E**

Weeks, Edwin Ruthven, Consulting Engineer, 3408 Harrison St., Kansas City, Mo. (50). **A B D I**

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*Weems, J. B., Ph. D., Agric. College, Ames, Iowa. (44). 1900. **C**

Weems, Mason Locke, Instructor in Physiology, Valparaiso College, Valparaiso, Ind. (52). **K**

Weimer, Edgar A., M. E., Supt. Weimer Machine Works Co., Lebanon, Pa. (51). **D**

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Weinzirl, John, Vice Director, Hadley Clim. Lab., Univ. of New Mexico, Albuquerque, New Mex. (45). **G**

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*Welch, William Henry, M. D., 935 St. Paul St., Baltimore, Md. (47). 1900. **F H**

*Weld, Laenas Gifford, Dean of Graduate College, State University of Iowa, Iowa City, Iowa, (41). 1895. **A**

Welin, John E., Professor of Physics and Chemistry, Bethany College, Lindsborg, Kansas. (50). **B C E**

Wells, Eliab Horatio, M. D., Professor of Natural Science, Baylor Female College, Belton, Texas. (50). **F K**

Wells, Frank, M. D., 178 Devonshire St., Boston, Mass. (47). **C**

Wells, Samuel, 45 Commonwealth Ave., Boston, Mass. (24). **H**

Wells, William H., Jr., 2 Norfolk St., Strand, W. C., London, England. (39). **E**

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Wendling, Hon. Geo. R., Cosmos Club, Washington, D. C. (52). **I**

Wenner, Francis W., Supt. of Public Schools, North Baltimore, Wood Co., Ohio. (51). **B**

Wesson, David, Southern Cotton Oil Co., Savannah, Ga. (50). **C**

West, Haarlem Ethneen, Mining Engineer, General Manager Pacific Northwest Mining Corporation, Libby, Mont. (50). **D**

West, Thomas Dyson, M. E., Mgr., T. D. West Engrg. Co., Sharpsville, Pa. (51). **D**

Westgate, Lewis Gardner, Ph. D., Professor of Geology, Ohio Wesleyan University, Delaware, Ohio. (51). **E**

*WESTINGHOUSE, GEORGE, Pittsburg, Pa. (50). 1902. **D**

Westinghouse, Henry Herman, Wilmerding, Pa. (51). **D**

*Weston, Edward, 645 High St., Newark, N. J. (33). 1887. **B C D**

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Weygant, Colonel Charles H., Newburgh, N. Y. (50). **I**

Weysse, Arthur W., Instructor in Zoology, Massachusetts Inst. of Technology, Boston, Mass. (52). **F**

Wheatland, Marcus F., M. D., 84 John St., Newport, R. I. (51). **H K**

Wheatley, Frank G., M. D., 47 Adams St., North Abington, Mass (51). **K**

*Wheeler, Alvin Sawyer, Ph. D., Associate Professor of Chemistry, University of North Carolina, Chapel Hill, N. C. (50). 1901. **C**

Wheeler, Chas. Fay, U. S. Department Agriculture, Washington, D. C. (52). **G**

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Wheeler, E. B., Union College, Schenectady, N. Y. (52).

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*Wheeler, Eben S., U. S. Engineer Office, Detroit, Mich. (50). 1901. D

*Wheeler, Henry Lord, Sheffield Lab., New Haven, Conn. (50). 1901. C

Wheeler, Horace Leslie, Watertown, Mass. (52). A E

Wheeler, Schuyler Skaats, Ampere, N. J. (50). D

Wheeler, William, C. E., Concord, Mass. (41).

*Wheeler, William Morton, Professor of Zoology, University of Texas, Austin, Texas. (50). 1901. F

Whelpley, James D., 1417 G St. N.W., Washington, D. C. (52). I

Whitaker, Milton C., Dept. of Chemistry, Columbia University, New York, N. Y. (50).

White, Charles G., Lake Linden, Mich. (46). B C

White, Charles H., U. S. N., Center Sandwich, N. H. (34). C

*White, David, U. S. Geol. Survey, Washington, D. C. (40). 1892. E F

*White, Horace, Editor "New York Evening Post," 18 W. 69th St., New York, N. Y. (50). 1901. I

*White, H. C., Ph. D., University of Georgia, Athens, Ga. (29). 1885. C

*White, Prof. I. C., State Geologist of West Virginia, Morgantown, W. Va. (25). 1882. E

White, John Williams, 18 Concord Ave., Cambridge, Mass. (47).

White, LeRoy S., 19 Buckingham Ave., Waterbury, Conn. (23).

White, Mrs. Mary Bell, 1615 New Hampshire Ave., N.W., Washington, D. C. (52).

White, Oscar W., 1116 F St., N.W., Washington, D. C. (52).

White, Walter Henry, M. D., 220 Marlborough St., Boston, Mass. (51). K

Whitehorne, Wm. Risby, Ph. D., Professor of Chemistry, Mullinburg College, 462 Walnut St., Allentown, Pa. (52). C

*Whitfield, J. Edward, 406 Locust St., Philadelphia, Pa. (44). 1896. C

*Whitfield, R. P., Amer. Mus. Nat. History, Central Park, New York, N. Y. (18). 1874. E F H

Whitham, Wm. Henry, Assistant in Physics, W. Va. University, Morgantown, W. Va. (52). B

Whiting, S. B., 11 Ware St., Cambridge, Mass. (33). D

*Whiting, Miss Sarah F., Professor of Physics, Wellesley College, Wellesley, Mass. (31). 1883. A B

*Whitman, Prof. Charles O., University of Chicago, Chicago, Ill. (43). 1898. F

*Whitman, Prof. Frank P., Adelbert College, Cleveland, Ohio. (33). 1885. A B

*Whitney, Miss Mary W., Vassar College, Poughkeepsie, N. Y. (47). 1900. A

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Whitney, Solon F., Public Library, Watertown, Mass. (52).

*Whitney, Willis Rodney, Mass. Inst. Tech., Boston, Mass. (46). 1900. **C**

Whitside, Samuel M., Brig. Gen., U. S. A., 1748 P St., N.W., Washington, D. C.

Whitted, Thomas Byrd, General Elec. Co., Denver, Colo. (50). **D**

Whittemore, Williams C., 1526 N. H. Ave., Washington, D. C. (49).

Wiechmann, F. G., M. D., 310 West 80th St., New York, N. Y. (50). **F K**

*Wiegand, Karl McKay, Ph. D., Cornell University, Ithaca, N. Y. (45). 1899. **G**

Wightman, Merle J., Electrical Engineer, 302 Broadway, New York, N. Y. (50). **D**

Wilbour, Mrs. Charlotte B., 40 Central Park, South, New York, N. Y. (28).

*Wilbur, A. B., Middletown, N. Y. (23). 1874. **E**

*Wilbur, Ray Lyman, M. D., Assistant Professor of Physiology, Stanford University, Cal. (50). 1901. **F K**

Wilcox, Mrs. Aaron Morley, The Arlington, Washington, D. C. (52).

*Wilcox, Edwin Mead, Ph. D., Prof. of Biology, Ala. Poly. Inst. Auburn, Ala. (50). 1901. **F G**

Wilcox, Miss Emily T., Middletown, Conn. (33). **A B**

*Willcox, Miss Mary Alice, Ph. D., Professor of Zoology, Wellesley College, Wellesley, Mass. (50). 1901. **F**

*Willcox, Walter F., Ph. D., Professor of Economics, Cornell University, Ithaca, N. Y. (50). 1901. **I**

Wilcox, William W., Inventor and Manufacturer, 187 South Main St., Middletown, Conn. (50). **D I**

*Wilder, Burt Green, Prof. of Neurology, Cornell University, Ithaca, N. Y. (51). 1902. **K**

Wilder, Harris Hawthorne, Ph. D., Professor of Zoology, Smith College, Northampton, Mass. (52). **F**

Wiley, Andrew J., C. E., Chief Engr. Boise-Payette River Electric Power Co., Boise, Idaho. (51). **D**

*Wiley, Harvey W., Ph. D., U. S. Dept. Agriculture, Washington, D. C. (21). 1874. **C**

Wiley, William H., C. E., 43 E. 19th St., New York, N. Y. (50). **D E**

Wilkins, Miss Lewanna, Eastern High School, Washington, D. C. (52). **F G**

Wilkins, Wm. Glyde, C. E., Westinghouse Bldg., Pittsburg, Pa. (50). **D E**

*Wilkinson, Levi Washington, Professor of Industrial and Sugar Chemistry, Tulane University, New Orleans, La. (50). 1903. **C**

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Willard, Julius Terrass, Dir. Kans. State Exper. Sta., Manhattan, Kans. (50). **C**

Wille, Henry Valentin, M. E., Engineer of Tests, Baldwin Locomotive Works, 2600 Girard Ave., Philadelphia, Pa. (51). **D**

Williams, Arthur, The New York Edison Co., 55 Duane St., New York, N. Y. (50). **D**

*Williams, Benezette, 153 La Salle St., Chicago, Ill. (33). 1887. **D**

Williams, Charles B., North Carolina Dept. of Agric., Raleigh, N. C. (47).

*Williams, Charles H., M. D., 1069 Boylston St., Boston, Mass. (22). 1874.

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Williams, Charles S., 166 Montgomery St., Newburgh, N. Y. (50). **I**

*Williams, Prof. Edw. H., Jr., Andover, Mass. (25). 1894. **D E**

*Williams, Francis H., M. D., 505 Beacon St., Boston, Mass. (29). 1890.

Williams, Frank H., Greene, N. Y. (50). **D**

*Williams, Prof. Henry Shaler, Yale University, New Haven, Conn. (18). 1882. **E F**

Williams, Ira Abraham, Assistant Professor of Geology and Mining Engineering, Iowa State College, Ames, Iowa. (52). **D E**

Williams, J. C., 221 Orchard St., Ridgeway, Pa. (51). **E**

Williams, Jacob Lafayette, M. D., 4 Walnut St., Boston, Mass. (51). **K**

*Williams, Dr. J. Whitridge, Professor of Obstetrics, Johns Hopkins University, Baltimore, Md. (50). 1901. **F K**

Williams, Leonard Worcester, Brown University, Providence, R. I. (52).

Williams, Miss Mabel Clare, Iowa City, Iowa. (52). **H**

Williams, Stephen Riggs, Professor of Biology, Miami University, Oxford, Ohio. (50). **F**

Williamson, Edward Bruce, Bluffton, Ind. (50). **F**

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Willis, Bernard Darwin, care Stromberg-Carlson Telephone Mfg. Co., 70-86 W. Jackson Boulevard, Chicago, Ill. (52).

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Williston, Dr. Samuel W., University of Chicago, Chicago, Ill. (51). **F K**

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Wills, Joseph Lainson, F. C. S., Chief of Laboratories, National Brewers' Academy, 133 Midwood St., Brooklyn, N. Y. (50). B C F

WILMARTH, MRS. HENRY D., 51 Eliot St., Jamaica Plain, Mass. (40).

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Wilson, Alisan, The Lenox, Washington, D. C. (52). H

Wilson, Prof. Andrew G., Hebron, Neb. (43). E

Wilsón, Charles Branch, State Normal School, Westfield, Mass. (52). F

*Wilson, E. B., Columbia University, New York, N. Y. (49). 1900.

Wilson, Fredk. Morse, M. D., 834 Myrtle Ave., Bridgeport, Conn. (51). K

*Willson, Prof. Frederick N., Princeton, N. J. (33). 1887. A D

*Wilson, Henry Van Peters, Professor of Biology, University of North Carolina, Chapel Hill, N. C. (50). 1901. F

Wilson, John C., Cosmos Club, Washington, D. C. (49). I

Willson, Mortimer, M. D., Port Huron, Mich. (50). A F

Wilson, Robert Lee, M. D., Assistant Surgeon, U. S. Marine Hospital Service, Box 274, Honolulu, T. H. (50). K

*Willson, Robert W., Cambridge, Mass. (30). 1890. A B

Wilson, Mrs. Thomas, 1218 Connecticut Ave., N.W., Washington. D. C. (52). H

Wilson, William Hyatt, Prof. of Mathematics, Univ. of Wooster, Wooster, Ohio. (50). A

*Wilson, Prof. William Powell, Philadelphia Commercial Museum, 233 S. 4th St., Philadelphia, Pa. (38). 1889. G

Winchell, Alexander Newton, Professor of Geology and Mineralogy, State School of Mines, Butte, Mont. (50). E

*Winchell, Horace V., Butte, Montana. (34). 1890. C E

*Winchell, Prof. N. H., Minneapolis, Minn. (19). 1874. E H

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Wingate, Miss Hannah S., 23 W. 129th St., New York, N. Y. (31). E I

*Winslow, Charles Edward Amory, Instructor in Biology, Mass. Inst. Tech., Boston, Mass. (51). 1903. F K

Winter, Mahlon A., 339 Penna. Ave., Washington, D. C. (52). D E I K

*Winterhalter, A. G., Lt. Com. U. S. N., Box 1479, G. P. O., New York, N. Y. (37). 1893. A

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*Withers, Prof. W. A., A. and M. College, Raleigh, N. C. (33). 1891. C

Witherspoon, Thomas A., Patent Office, Dept. of Interior, Washington, D. C. (52). C

Witmer, Lightner, Ph. D., Asst. Prof. Psychology, Univ. of Pennsylvania, Philadelphia, Pa. (46). H

Witte, Max Ernest, M. D., Superintendent of Clarinda State Hospital, Clarinda, Ia. (51). K

*Witthaus, Dr. R. A., Cornell Medical College, 1st Ave., and 28th St., New York, N. Y. (35). 1890.

Wolcott, Mrs. Henrietta L. T., Dedham, Mass. (29).

Wolf, August S., Examiners' Room, Equitable Life Assurance Society, 120 Broadway, New York, N. Y. (49).

Wolfe, Elmer Ellsworth, Ph. D., Principal of the Academy, Marietta College, Marietta, Ohio. (51). B C G

Wölfel, Paul, Chief Engineer, American Bridge Co., N.W. Cor. 15th and Chestnut Sts., Philadelphia, Pa. (51). D

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*Wolff, Dr. John E., University Museum, Cambridge, Mass. (36). 1894. E

*Woll, Fritz Wilhelm, Madison, Wis. (42). 1897. C

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Wood, Matthew P., Consulting Engineer and Mechanical Expert, 234 W. 44th St., New York, N. Y. (51). D

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Wood, Stuart, 400 Chestnut St., Philadelphia, Pa. (51).

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Wood, Walter, 400 Chestnut St., Philadelphia, Pa. (33). F I

Woodberry, Miss Rosa Louise, Teacher of Natural Science, Lucy Cobb Institute, Athens, Ga. (51). B C

Woodbridge, Frederick J., Professor of Philosophy, Columbia University, New York, N. Y. (52).

Woodbridge, Tyler Reed, C. E., care The Taylor and Brunton Sampling Co., Victor, Colo. (50). D

*Woodbury, C. J. H., Amer. Bell Telephone Co., 125 Milk St., Boston, Mass. (29). 1884. D

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*Woodhull, John Francis, Teachers' College, Morningside Heights, New York, N. Y. (43). 1899.

Woodhull, Gen. Maxwell Van Zandt, U. S. A., 2033 G St., N.W., Washington, D. C. (52).

*Woodman, Durand, Ph. D., 127 Pearl St., New York, N. Y. (41). 1896.

*Woods, Albert F., U. S. Dept. Agric., Washington, D. C. (43). 1897. **G**

*Woods, Charles D., Professor of Agriculture, University of Maine, Orono, Maine. (50). 1901. **G**

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WATERTOWN.

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WAVERLEY.

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WEYMOUTH.

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WELLESLEY.

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BUTTE.

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Warren, George F., Jr.

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Starr, Elmer G., 523 Delaware Avenue.
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Sherman, Henry C., Columbia University.
Sherwood-Dunn, B., 26 Broadway.
Shiland, Andrew, Jr., 262 West 78th Street.
Sickles, Irvin, 17 Lexington Avenue.
Skeel, Frank D., 58 East 25th Street.
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Soper, George A., 29 Broadway.
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Stanton, Robert B., 66 Broadway.
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Starrett, M. G., 349 West 85th Street.
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Strong, Wendell M., 32 Nassau Street.
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Hyatt, William.
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McMullen, Joseph F., 1908 Nora Avenue.

STARBUCK.

Pietrzycki, Marcel.

TACOMA.

Gault, Franklin B., 602 North I Street.

WEST VIRGINIA.

ATHENS.

Goodwin, Elmer Forrest, State Normal School.

BOOMER.

Sharp, Charles Cutler, Raven Coal and Coke Company.

CHARLESTON.

Brooks, Earle Amos.
Cargill, George W.

CLARKSBURG.

Davis, John J.
Smith, Harvey F.

FAIRMONT.

Sands, Wm. Hupp.

MARTINSBURG.

McCune, M. Virginia, 506 West John Street.

MORGANTOWN.

Brock, Luther S.
Brown, Samuel B.
Clark, Friend E., West Virginia University.
Fast, Richard Ellsworth, West Virginia University.
Hennen, Ray V., L. B. 448.
Hodges, Thomas Edward, West Virginia University.
Johnson, Thomas Carskadon, 375 Spruce Street.
Johnston, John Black, West Virginia University.
Jones, Clement Ross, West Virginia University.
Maxwell, Hu.
Morris, Russell Love, West Virginia University.
Patterson, Chas. H., West Virginia University.
Stewart, James H., Agricultural Experiment Station.
White, I. C., West Virginia University.
Witham, William Henry, West Virginia University.

PHILIPPI.

Lemley, C. McC.

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WHEELING.

Crockard, Frank Hearne, Lock Box 34.

WISCONSIN.

BELOIT.

Smith, Erastus G., Beloit Sanitary Laboratory.
Smith, Thomas A., Beloit College.

DELAVAN.

Walker, E. W., State School for the Deaf.

FOND DU LAC.

Molitor, David, 125 Park Avenue.

GREEN BAY.

Schuette, J. H.

KENOSHA.

Windesheim, Gustave, 255 Main Street.

MADISON.

Babcock, S. Moulton, 432 Lake Street.
Bull, Storm.
Cheney, Lellen Sterling, 318 Bruen Street.
Clements, Julius Morgan, University of Wisconsin.
Comstock, George C., University of Wisconsin.
Flint, Albert S., Washburn Observatory.
Frost, William Dodge, University of Wisconsin.
Goff, E. S., 1113 University Avenue.
Hillyer, Homer W., University of Wisconsin.
Hobbs, William Herbert.
Jastrow, Joseph, University of Wisconsin.
Kahlenberg, Louis, University of Wisconsin.
Kremers, Edward, University of Wisconsin.
Lenher, Victor, University of Wisconsin.
Longden, A. C., Wisconsin Avenue.
Mendenhall, Charles E., University of Wisconsin.
Miller, William S., University of Wisconsin.
Russell, H. L., University of Wisconsin.
Slichter, Charles S., University of Wisconsin.
Snow, Benjamin W., 518 Wisconsin Avenue.
Trowbridge, Augustus, University of Wisconsin.
Turneaure, Frederic E., University of Wisconsin.
Van Hise, Charles R., University of Wisconsin.
Woll, Fritz Wilhelm.

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MENOMONIE.

Davis, Kary Cadmus.

MILTON.

Daland, William Clifton.

MILWAUKEE.

Albrecht, Sebastian, 767 Forest Home.
Beach, William Harrison, 229 Pleasant Street.
Becher, Franklin A., 234 Oneida Street.
Case, Ermine Cowles, State Normal School.
Conway, George M., 10 Belvedere.
Friend, Samuel Henry, 141 Wisconsin Street.
Kletzsch, Gustav A., 453 Cass Street.
Mitchell, Andrew S., 220 Greenbush Street.
Neilson, Walter Hopper, 114 Garfield Avenue.
Nolte, Lewis G., Senn's Block.
Ogden, Henry Vining, 141 Wisconsin Street.
Sherman, Lewis, 448 Jackson Street.
Stickney, Gardner P., care Oliver C. Fuller & Company.
Uihlein, August, 332 Galena Street.
Ward, Henry L., Public Museum.
Wright, Clement Blake Bergen, 796 Astor Street.

NORTH FREEDOM.

LaRue, William Gordon.

OCONOMOWOC.

Voje, John Henry, Private Sanatorium, Waldheim.

RACINE.

Davis, J. J., 1119 College Avenue.

RIPON.

Chandler, Charles Henry.
Marsh, C. Dwight, Ripon College.

SOUTH MILWAUKEE.

Knox, S. L. Griswold, care Bucyrus Company.

WAUWATOSA.

Grosskopf, Ernest C., Milwaukee County Hospital.

WILLIAMS BAY.

Barnard, Edward E., Yerkes Observatory.
Frost, Edwin Brant, Yerkes Observatory.
Hale, George E., Yerkes Observatory.
Schlesinger, Frank, Yerkes Observatory.

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WYOMING.

BUFFALO.

Onderdonk, Henry U.

CASPER.

Salathé, Frederick, Penna. Oil and Gas Company.

CHEYENNE.

Bond, Fred.
Morris, Robert C., Clerk of Wyoming Supreme Court.

FOUR BEAR.

Pickett, William Douglas.

LARAMIE.

Buffum, Burt C.
Nelson, Aven, University of Wyoming.
Slosson, Edwin E., University of Wyoming.

RAWLINS.

Carter, James.

SHERIDAN.

Coffeen, H. A.

FOREIGN.

BRAZIL.

SAO PAULO.

Derby, Orville A.
Lane, Horace Manley, Caixa 14.
von Ihering, F., Museu Paulista.

BRITISH COLUMBIA.

ROSSLAND.

Thompson, William, Rossland Great Western Mines, Limited.

VICTORIA.

Sutton, William J.

CANADA.

ACTON VALE.

Würtele, John Hunter.
Würtele, Louis C.

BARRIE.

Hunter, Andrew Frederick.

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CHATHAM.

Macfarlane, A., Gowrie Grove.

DAWSON.

Tyrrell, Joseph B.

FREDERICTON.

Riley, Isaac Woodbridge.

GUELPH.

Doherty, Manning W., Ontario Agricultural College.
Lochhead, William, Ontario Agricultural College.
Mills, James, Ontario Agricultural College.

HALIFAX.

Murray, Daniel A., Dalhousie College.

LINDSAY.

Cornish, George A.

MONTREAL.

Burgess, Thomas J. W., Protestant Hospital for the Insane.
Butler, Matthew J., 877 Dorchester Street.
Cox, John, McGill University.
Holt, Herbert S., Montreal Light, Heat and Power Company.
Iles, George, 5 Brunswick Street.
Lampard, Henry, 102 Shuter Street.
Loeb, Leo, McGill University.
Lyman, Henry H., 74 McTavish Street.
Mills, Wesley, McGill University.
Schenck, Charles C., McGill University.
Walls, John Albert, 990A Sherbrooke Street.

OTTAWA.

Bell, Robert, Geological Survey.
Fletcher, James, Experimental Farm.
Harmon, Miss A. Maria, 171 McLaren Street.
Klotz, Otto Julius, 437 Albert Street.
Saunders, Charles E., Experimental Farm.
Saunders, William, Experimental Farm.
Whiteaves, J. F., Geological Survey.

QUEBEC.

Laflamme, J. C. K., Laval University.

STANSTEAD.

Moore, Mrs. A. H.

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TORONTO.

Galbraith, John, School of Practical Science.
James, Charles C., Department of Agriculture.
Kammerer, Jacob Andrae.
Kirschmann, A., Toronto University.
McCurdy, Arthur W., 143 Bloor Street, West.
McLennan, J. C., Toronto University.
Spencer, J. William, 152 Bloor Street.
Walker, Byron Edmund.

ENGLAND.

LAMPETER.

Scott, Arthur William, St. David's College.

LONDON.

Hoover, Herbert C., care Bewick, Morring & Co., Broad Street House, New Broad Street.
Power, Frederick B., 6 King Street, Snow Hill, E. C.
Wells, Wm. H., Jr., 2 Norfolk Street, Strand, W. C.

OXFORD.

Myres, John L., Christ Church.

ROTHAMSTED.

Warington, Robert.

FRANCE.

PARIS.

Loubat, Le Duc De, 47 rue Dumont d'Urville.

GERMANY.

BERLIN.

Hoffmann, Friedrich, Charlottenburg, Kant Street 125.
Magee, Louis J., Grosse Quer Allee 1.

BONN.

Miyake, Küchi, Botanisches Institut, Universitat zu Bonn.

HUNGARY.

BUDAPEST.

Krécsy, Béla, VI Bulyovsxky u. 22.

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San Remo.

Kuntze, Otto, Villa Girola.

JAPAN.

Kobe.

Hoyt, Olive Sawyer, Kobe College.

Tokyo.

Loew, Oscar.

Yokohama.

Gause, Fred. Taylor.

MEXICO.

Aguascalientes.

Morse, Willard S.

Cedral.

Alexander, Curtis.

City of Mexico.

de Arozarena, Rafael M., 2 da Calle de las Estaciones.
Hard, James M. B., Cordobanes 16.
Sercombe, Parker H., 1a Calle San Francisco No. 8.

Colima.

Herbert, Arthur P.

Cordoba.

Bowman, Joseph H.

Coyoacan, D. F.

Nuttall, Mrs. Zelia, Casa Alvarado.

Guadalajara.

Schiaffino, Mariano L.

Guadalupe y Calvo.

Schiertz, Ferdinand A.

Jalapa.

Gutierrez, Manuel R.

Linares.

McLimont, Andrew W.

Monclova.

Cerna, David.

Monterey.

Dysterud, E.

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PACHUCA.

De Landero, Carlos F.

SALTILLO.

Abbott, Theodore Sperry.
Burton, Standish B.

SAN JOSE DE GRACIA.

Tays, Eugene A. H., Anglo-Mexican Mining Company.

SAN NICOLAS DEL ORO.

Miller, Henry Huntington.

SOMBRERETE.

McMahan, Charles Hays.

TORRES.

Peterson, Bertel.

VERA CRUZ.

Parker, Herman B.

VILLA CORONA.

Carnaghan, Edwin D.

NICARAGUA.

LEON.

Crawford, John.

SICILY.

CATANIA.

Scaife, Walter B., care A. W. Elford.

SOUTH AFRICA.

CAPE TOWN.

Mally, Charles William, Department of Agriculture.

PRETORIA.

Davy, Joseph Burtt, Department of Agriculture.
Simpson, Charles Baird, Department of Agriculture.

TURKEY.

HARPUT.

Norton, Thomas H., United States Consulate.

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DECEASED MEMBERS.

[A list of deceased members of the Association, so far as known at the time of publishing the volume of Proceedings of the Springfield meeting, May, 1896, is given in that volume. At the Buffalo meeting the Council directed the Permanent Secretary to omit the printing of the full list of deceased members in the annual volumes and to print only the additions to the list. Since the publication of the list printed in the Pittsburg Proceedings (Vol. 51) notices have been received of the decease of the following members.]

BARGE, B. F., Mauch Chunk, Pa. (33). Died October 30, 1902.

Brühl, Gustav, John and Hopkins Sts., Cincinnati, Ohio. (28).

Carnell, Frederic James, Yale University, New Haven, Conn. (50). Died November 15, 1902.

Chester, Albert H., Rutgers College, New Brunswick, N. J. (29). Died April 13, 1903.

Clark, Edward, 417 4th St., N.W., Washington, D. C. (40). Died January 6, 1903.

Clark, Joseph E., St. Peters Hospital, Brooklyn, N. Y. (43). Died January 19, 1903.

Crombie, John B., 500 North Avenue West, Allegheny, Pa. (51). Died December 22, 1902.

Davis, J. Woodbridge, 523 W. 173d St., New York, N. Y. (47). Died November 7, 1902.

Dunn, Miss Louise Brisbin, Columbia University, New York, N. Y. (47).

Fox, Oscar C., U. S. Patent Office, Washington, D. C. (36). Died June 6, 1902.

Greene, J. Evarts, 98 Lincoln St., Worcester, Mass. (47). Died November 8, 1902.

Greenleaf, Robert Willard, 561 Boylston St., Boston, Mass. (47).

Harkness, William, U. S. Naval Observatory, Washington, D. C. (26). Born December 17, 1837. Died February 28, 1903.

Herthel, Adolph, 1739 Waverly Place, St. Louis Mo. (50). Died October 15, 1901.

Hewitt, Abram S., 9 Lexington Avenue, New York, N. Y. (49).

Hoffman, Eugene Aug., 1 Chelsea Square, New York, N. Y. (36). Died June 17, 1902.

James, Bushrod W., 18th and Green Sts., Philadelphia, Pa. (29). Died January 6, 1903.

Jesup, James R., 555 Fifth Ave., New York, N. Y. (50). Died February 26, 1902.

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Kedzie, Robert C., Agricultural College, Mich. (29). Died November 7, 1902.

Lesley, J. Peter, P. O. Box 93, Milton, Mass. (2).

Lord, Benjamin, 34 W. 28th St., New York, N. Y. (36). Died May 3, 1902.

Osborn, Mrs. W. H., 32 Park Ave., New York, N. Y. (50).

Packard, Frederick A., 258 So. 18th St., Philadelphia, Pa. (51). Died November 1, 1902.

Powell, J. W., Washington, D. C. (23).

Putnam, Mrs. Mary L. D., Davenport, Iowa. (50). Died February 20, 1903.

Rich, Jacob Monroe, 50 West 38th St., New York, N. Y. (33). Died March 20, 1903.

Richardson, Alonzo Blair, Government Hospital for Insane, Washington, D. C. (50). Died June 27, 1903.

Rood, Ogden N., Columbia University, New York, N. Y. (14). Died November 12, 1902.

Roosevelt, Mrs. Marion T., 57 Fifth Ave., New York, N. Y.

Runkle, John D., 15 Everett St., Cambridge, Mass. (2). Died July 8, 1902.

Wilson, Joseph Miller, Drexel Building, Philadelphia, Pa. (33).

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ADDRESS

BY

ASAPH HALL,

THE RETIRING PRESIDENT OF THE ASSOCIATION.

THE SCIENCE OF ASTRONOMY.

I take for the subject of my address the science of astronomy, and propose to give a brief historical sketch of it, to consider its future development, and to speak of the influence of the sciences on civilization.

The science of astronomy is so closely connected with the affairs of life, and is brought into use so continuously and in such a systematic manner, that most people never think of the long labor that has been necessary to bring this science to its present condition. In the early times it was useful to the legislator and the priest for keeping records, the times of public ceremonies and of religious festivals. It slowly grew into the form of a science, and became able to make predictions with some certainty. This was many centuries ago. Hipparchus, who lived 150 B. C., knew the periods of the six ancient planets with considerable accuracy. His periods are:

	Period.	$\frac{\text{Error} \times 100}{\text{Period}}$
Mercury	$87^d.9698$	$+ 0^d.0007$
Venus	224.7028	+ 0.0009
Earth	365.2599	+ 0.0010
Mars	686.9785	— 0.0002
Jupiter	4332.3192	— 0.0061
Saturn	10758.3222	— 0.0083

These results indicate that more than two thousand years ago there existed recorded observations of astronomy. Hip-

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parchus appears to have been one of those clear-headed men who deduce results from observations with good judgment. There was a time when those ancient Greek astronomers had conceived the heliocentric motions of the planets, but this true theory was set aside by the ingenious Ptolemy, who assumed the earth as the center of motion, and explained the apparent motions of the planets by epicycles so well that his theory became the one adopted in the schools of Europe during fourteen centuries. The Ptolemaic theory flattered the egotism of men by making the earth the center of motion, and it corresponded well with old legends and myths, so that it became inwoven with the literature, art and religion of those times. Dante's construction of Hell, Purgatory and Paradise is derived from the Ptolemaic theory of the universe. His ponderous arrangement of ten divisions of Paradise, with ten Purgatories, and ten Hells, is said by come critics to furnish convenient places for Dante to put away his friends and his enemies, but it is all derived from the prevailing astronomy. Similar notions will be found in Milton, but modified by the ideas of Copernicus, which Milton had learned in Italy. The Copernican theory won its way slowly, but surely, because it is the system of nature, and all discoveries in theory and practical astronomy helped to show its truth. Kepler's discoveries in astronomy, Galileo's discovery of the laws of motion, and Newton's discovery of the law of gravitation, put the Copernican theory on a solid foundation. Yet it was many years before the new theories were fully accepted. Dr. Johnson thought persecution a good thing, since it weeds out false men and false theories. The Copernican and Newtonian theories have stood the test of observation and criticism, and they now form the adopted system of astronomy.

The laws of motion, together with the law of gravitation, enable the astronomer to form the equations of motion for the bodies of our solar system; it remains to solve these equations, to correct the orbits, and to form tables of the Sun, Moon and the planets. This work was begun more than a century ago, and it has been repeated for the principal

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planets several times, so that now we have good tables of these bodies. In the case of the principal planets the labor of determining their orbits was facilitated by the approximate orbits handed down to us by the ancient astronomers; and also by the peculiar conditions of these orbits. For the most part the orbits are nearly circular; the planets move nearly in the same plane, and their motions are in the same direction. These are the conditions Laplace used as the foundation of the nebular hypothesis. With approximate values of the periods and motions, and under the other favoring conditions, it was not difficult to form tables of the planets. However the general problem of determining an orbit from three observations, which furnish the necessary and sufficient data, was not solved until about a century ago. The orbits of comets were first calculated with some precision. Attention was called to these bodies by their threatening aspects, and by the terror they inspired among people. It was therefore a happy duty of the astronomers to show that the comets also move in orbits around the Sun, and are subject to the same laws as the planets. This work was easier because the comets move nearly in parabolas, which are the simplest of the conic sections. Still the general problem of finding the six elements of an orbit from the six data given by three observations remained to be solved. The solution was given by Gauss a century ago in a very elegant manner. His book is a model, and one of the best ever written on theoretical astronomy. No better experience can be had for a student than to come in contact with such a book and with such an author. The solution of Laplace for the orbit of a comet is general, but demands more labor of computing than the methods of Olbers, as arranged by Gauss. It is said by some writers that the method of Laplace is to be preferred because more than three observations can be used. In fact, this is necessary in order to get good values of the derivatives of the longitudes and latitudes with respect to the time, but it leads to long and rather uncertain computations. Moreover it employs more data than are necessary, and thus is a departure from the mathematical

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theory of the problem. This method is ingenious, and by means of the derivatives it gives an interesting rule for judging of the distance of a comet from the earth by the curvature of its apparent path, but a trial shows that the method of Olbers is much shorter. Good preliminary orbits can now be computed for comets and planets without much labor. This, however, is only a beginning of the work of determining their actual motions. The planets act on each other and on the comets, and it is necessary to compute the result of these forces. Here again the conditions of our solar system furnish peculiar advantages. The great mass of the sun exerts such a superior force that the attractions of the planets are relatively small, so that the first orbits, computed by neglecting this interaction, are nearly correct. But the interactions of planets become important with the lapse of time, and the labor of computing these perturbations is very great. This work has been done repeatedly, and we now have good numerical values of the theories of the principal planets, from which tables can be made. Practically, therefore, this question appears to be well toward a final solution. But the whole story has not been told.

The planets, on account of their relative distances being great and because their figures are nearly spherical, can be considered as material particles and then the equations of motion are readily formed. In the case of n material particles acting on each other by the Newtonian law, and free from external action, we shall have $3n$ differential equations of motion, and $6n$ integrations are necessary for the complete solution. Of these only ten can be made, so that in the case of only three bodies there remain eight integrations that cannot be found. The early investigators soon obtained this result, and it is clearly stated by Lagrange and Laplace. The astronomer, therefore, is forced to have recourse to approximate methods. He begins with the problem of two bodies, the sun and a planet, and neglects the actions of the other planets. In this problem of two bodies the motions take place in a plane, and the integrations can all be made. Two constants are needed to fix the position of the plane of motion,

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and the four other constants pertaining to the equations in this plane are easily found. This solution is the starting point for finding the orbits of all the planets and comets. The mass of the sun is so overpowering that the solution of the problem of two bodies gives a good idea of the real orbits. Then the theory of the variation of the elements is introduced, an idea completely worked out into a practical form by Lagrange. The elements of the orbits are supposed to be continually changed by the attractions of the other planets. By means of this theory, and the mathematical machinery given by Lagrange, which can be applied to a great variety of questions, the observations of the planets can be satisfied over long intervals of time. When this theory of the motions was carried out a century ago it appeared that the great problem of planetary motion was near a complete solution. But this solution depends on the use of series, which undergo integrations that may introduce small divisors. An examination of these series by Hansen, Poincaré and others indicates that some of them are not convergent. Hence the conclusions formerly drawn about the stability of our solar system are not trustworthy, and must be held in abeyance. But looking at the construction of our system, and considering the manner in which it was probably evolved, it appears to be stable. However, the mathematical proof is wanting. In finding the general integrals of the motions of n bodies, the assumption that the bodies are particles gets rid of the motions of rotation. These motions are peculiar to each body, and are left for special consideration. In the case of the earth this motion is very important, since the reckoning of time, one of our fundamental conceptions, depends on this motion. Among the ten general integrals that can be found six belong to the progressive motion of the system of bodies. They show that the center of gravity of the system moves in a right line, and with uniform velocity. Accurate observations of the stars now extend over a century and a half, and we are beginning to see this result by the motion of our sun through space. So far the motion appears to be rectilinear and uniform, or the action of the stars is without influence.

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This is a matter that will be developed in the future. Three of the other general integrals belong to the theory of areas, and Laplace has drawn from them his theory of the invariable plane of the system. The remaining integral gives the equation of living force. The question of relative motion remains, and is the problem of theoretical astronomy. This has given rise to many beautiful mathematical investigations, and developments into series. But the modern researches have shown that we are not sure of our theoretical results obtained in this way, and we are thrown back on empirical methods. Perhaps the theories may be improved. It is to be hoped that the treatment of the differential equations may be made more general and complete. Efforts have been made in this direction by Newcomb and others, and especially by Gyldèn, but so far without much practical result.

The problem of three bodies was encountered by the mathematicians who followed Newton, and many efforts were made to solve it. These efforts continue, although the complete investigations of Lagrange appear to put the matter at rest. The only solutions found are of very special character. Laplace used one of these solutions to ridicule the doctrine of final causes. It was the custom to teach that the moon was made to give us light at night. Laplace showed by one of the special solutions that the actual conditions might be improved, and that we might have a full moon all the time. But his argument failed, since such a system is unstable and cannot exist in nature. But some of the efforts to obtain partial solutions have been more fruitful, and G. W. Hill has obtained elegant and useful results. These methods depend on assumed conditions that do not exist in nature, but are approximately true. The problem of two bodies is a case of this kind, and the partial solutions may illustrate, but will not overcome, the fundamental difficulty.

The arrangement of our solar system is such that the distances of the planets from one another are very great with respect to their dimensions, and this facilitates very much the determination of their motions. Should two bodies ap-

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proach very near each other the disturbing force might become great, even in the case of small masses. In the case of comets, this condition happens in nature, and the comet may become a satellite of a planet, and the sun a disturbing body. In this way it is probable that comets and meteoric streams have been introduced into our solar system. We have here an interesting set of problems. This question is sometimes treated as one of statics, but since the bodies are in motion it belongs to dynamics. Further study may throw light on some relations between the asteroids and the periodical comets.

The great question of astronomy is the complete and rigorous test of the Newtonian law of gravitation. This law has represented observations so well during a century and a half that it is a general belief that the law will prove true for all time, and that it will be found to govern the motions of the stars as well as those of our solar system. The proof is cumulative and strong for this generality. It will be a wonderful result if this law is found rigorously true for all time and throughout the universe. Time is sure to bring severe tests to all theories. We know that the law of gravitation is modified in the motions of the matter that forms the tails of comets. There is an anomaly in the theory of Mercury which the law does not explain, and the motion of our moon is not yet represented by theory. The lunar theory is very complicated and difficult, but it does not seem probable that the defect in Hansen's theory will be found by recomputing the periodical coefficients, that have been already computed by many mathematicians and astronomers, and with good agreement by Hansen and Delaunay, by very different methods. Hansen was a computer of great skill, but he may have forced an agreement with observations, from 1750 to 1850, by using a coefficient of long period with an erroneous value. No doubt the error of this theory will be discovered. Back of all theories, however, remains the difficulty of solving the equations of motions so that the result can be applied with certainty over long periods of time. Until this is done we shall not be able to subject our law to a crucial test.

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The constants that enter the theories of the planets and moon must be found from observations. In order to compare observations made at distant epochs, the motions of the planes of reference must be known with accuracy, and also the motion of our solar system in space. As the stars are our points of reference their positions and their proper motions must be studied with great care. This department of astronomy was brought to a high degree of order by the genius of Bessel, whose work forms an epoch in modern astronomy. The recent progress made in determining the positions of the stars in all parts of the heavens will be a great help to the investigations of the future. We must have observatories where accurate and continuous observations are made. Our country is well situated to supplement the work of Europe, and we hope it will never fail to add its contribution to the annals of astronomy. American astronomers should keep pace in the improvements for increasing the ease and accuracy of making observations. The spectroscope has given a new element in the motions of the stars, not to speak of the interesting physical results obtained by its use. Photography will give great aid in determining the relative positions of the stars and in forming maps of the heavens. All new methods, however, will need examination and criticism, since they bring new sources of error. Fifty years ago it was thought the chronograph would increase very much the accuracy of right ascensions. It has not done this directly to any great extent, but it has increased the ease and rapidity of observing. We must remember that astronomical results finally depend on meridian observations, and that it is the duty of astronomers to make these continuous from generation to generation. In this way we shall gain the powerful influence of time to help control and solve our problems. There is one point where a reform may be needed from the dead weight of the large and expanding volumes sent forth by observatories and scientific institutions. The desire for publication is great, but the results should be well discussed and arranged, so that the printing may be shortened. Otherwise our publications may become burdensome, and when they

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are piled up in libraries some future Caliph Omar may be tempted to burn them. Even mathematics appears to labor under a similar oppression, and much of its printed matter may be destined to moulder to useless dust.

In the not distant future stellar astronomy will become a great and interesting field of research. The data for the motions of the stars are becoming better known, but these motions are slow, and the astronomer of to-day looks with envy on the astronomer of a thousand years hence, when time will have developed these motions. Much may be done by the steady and careful work of observation and discussion, and the accumulation of accurate data. Here each one of us can add his mite. But the great steps of progress in science have come from the efforts of individuals. Schools and universities help forward knowledge by giving to many students opportunities to learn the present conditions, and from them some genius like Lagrange or Gauss may come forth to solve hard questions, and to break the paths for future progress. This is about all the schools can do. We need a body of men who can give their lives to quiet and continuous study. When the young Laplace was helped to a position where he could devote his life to research D'Alembert did more for the progress of astronomy than all the universities of Europe.

One needs only to glance at history to see how useful astronomy has been in the life of the world. It has wonderfully enlarged the universe, and widened the views of men. It shows how law and order pervade the world in which we live; and by the knowledge it has disseminated and by its predictions it has banished many superstitions and fears. The sciences will continue to grow, and they will exert the same influence. The erroneous and dogmatic assertions of men will be pushed aside. In our new country the energies of the people are devoted chiefly to commercial and political ends, but wealth is accumulating, leisure and opportunity will come, and we may look forward to a great development of scientific activity. We must be patient. Men do not change much from generation to generation. Nations that

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have spent centuries in robbery and pillage retain their dispositions and make it necessary for other nations to stand armed. No one knows when a specious plea for extending the area of civilization may be put forth, or when some fanatic may see the hand of God beckoning him to seize a country. The progress of science and invention will render it more difficult for such people to execute their designs. A century hence it may be impossible for brutal power, however rich and great, to destroy a resolute people. It is in this direction that we may look for international harmony and peace, simply because science will make war too dangerous and too costly.

The influence of the sciences in bringing men of different nationalities into harmony is great. This is done largely by the common languages that are formed in each science. In mathematics the language is so well formed and generally adopted that mathematicians all over the world have no trouble in understanding one another. It may be difficult to read Russian, but every one can read the formulas of Tchebitchef and Lobaschewsky. In astronomy the common language is nearly as well established, so that there is little difficulty in understanding the astronomy of different nations. A similar process is going on in chemistry, botany and in the other sciences. When men are striving for the discovery of truth in its various manifestations, they learn that it is by correcting the mistakes of preceding investigators that progress is made, and they have charity for criticism. Hence persecution for difference of opinion becomes an absurdity. The labors of scientific men are forming a great body of doctrine that can be appealed to with confidence in all countries. Such labors bring people together, and tend to break down national barriers and restrictions. The scientific creed is constantly growing and expanding, and we have no fears, but rejoice at its growth. We need no consistory of bishops, nor synod of ministers, to tell us what to believe. Everything is open to investigation and criticism.

In our country we have one of the greatest theaters for national life that the world has ever seen. Stretching three

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thousand miles from ocean to ocean, and coveiing the rich valleys of the great rivers, we have a land of immense resources. Here is a vast field for scientific work of various kinds. No doubt the men of the future will be competent to solve the problems that will arise. Let us hope that our national character will be just and humane, and that we may depart from the old custom of robbing and devouring weak peoples. Any one who saw the confusion and waste in this city in 1862 might well have despaired of the Republic; and he who saw the armies of Grant and Sherman pass through the city in 1865 felt that he need fear no foreign foe; neither French emperor, nor English nobleman, nor the sneers of Carlyle. To destroy a democracy by external force the blows must be quick and hard, because its power of recuperation is great. The danger will come from internal forces produced by false political and social theories, since we offer such a great field for the action of charlatans. Our schools and colleges send forth every year many educated people, and it is sometimes disheartening to see how little influence these people have in public life. Those who are trained in the humanities and churches ought to be humane in dealing with other people, ready to meet great emergencies and powerful to control bad tendencies in national affairs. But this is rarely the case. On the other hand the most unscrupulous apologists and persecutors have been educated men, and the heroes of humanity have come from the common people. This anomaly points to something wrong in the system of education which should disappear. The increase and teaching of scientific ideas will be the best means of establishing simple and natural rules of life. Nature, and science, her interpreter, teach us to be honest and true, and they lead us to the Golden Rule.

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SECTION A.

Mathematics and Astronomy.

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ADDRESS

BY

G. W. HOUGH,

VICE-PRESIDENT AND CHAIRMAN OF SECTION A FOR 1902.

ON THE PHYSICAL CONSTITUTION OF THE PLANET JUPITER.

The planet of Jupiter was one of the first objects to which the telescope of Galileo was directed, and the satellites of the planet were among the earliest discoveries made by that instrument. In 1630 the telescope had been constructed with sufficient power to show the great equatorial belt. Previous to the beginning of the eighteenth century the principal phenomena seen on the surface of Jupiter had been observed, and the time of rotation and position of the axis of the planet ascertained. Notwithstanding, however, the great mass of facts which have been collected from observations extending over a period of 200 years, yet up to the present time no theory of the physical condition of the surface has been advanced which has met with universal acceptance. In order that the subject may be more clearly understood it will be well to state briefly the salient features presented to the eye of the observer. The disk of Jupiter appears as an ellipse having axes in the ratio of 14 to 15, the longer axis lying in the direction of the planet's equator. The equatorial diameter is about 89,000 miles.

Now as the axis of the planet is nearly perpendicular to the line of sight, we shall see objects in their true dimensions only near the middle of the disk and on the equator. In the revolution of the planet in its orbit, the equator, as seen from the earth, may be displaced 3.3 degrees. Therefore, all ob-

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jects seen on the disk may apparently be shifted in latitude. At the equator the displacement may amount to 1.1″ of arc, or about one-sixteenth of the polar diameter, while in higher latitudes it will be very much less, and at the latitude of 70 degrees the displacement will be only 0.28″ of arc.

During the past twenty-five years some astronomers, who have observed Jupiter for years, imagine that when the planet is turned with its axis three degrees toward the earth, one would be able to see to the pole and beyond. I may say that this is a mistake, for the reason that the displacement of three degrees would amount to only 0.03″ near the pole. It is very rare that any objects are seen beyond 40 degrees of Jovian latitude. The latitude of 70 degrees is only 1″ from the limb, and 80 degrees only 0.25″ from the limb of the planet. Hence objects, if they existed at high latitudes, would be practically invisible. During twenty-three years of observation I have never observed a separate marking beyond 42 degrees of Jovicentric latitude, or 5.7″ of arc from the limb, except on one night when a small white spot was seen in latitude 62 degrees, or within 2″ of the south limb of the planet. Usually a fine shading or discoloration of the disk is seen near the poles. The planet rotates on its axis in a little less than ten hours, and hence the shape and size of an object in passing across the disk will be materially modified by the effect of rotation. An object, when it is first brought into view on the disk by rotation, is infinitely short in length and, as it is brought farther on by rotation, the length is increased, and reaches its maximum when on the central meridian of the disk. In passing off, it of course goes through the same changes in apparent size. As the meridians on a globe are curved lines, objects in passing across the disk may apparently be displaced in longitude in regard to each other, due to the curvature of the meridian, viz., two spots lying in different latitudes might at one time be on a line parallel to the polar axis of the planet and, when brought on the middle of the disk, would lie in different longitudes. Some astronomers have been misled by phenomena of this kind, considering it to be a real motion of the object, when in fact it is simply displacement due to rotation.

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In order then to know what phenomena are real and what are apparent, it is necessary to take into account the position of the earth with regard to Jupiter's equator, as well as the position of the object on the disk of the planet.

Jupiter is distant 5.2 times the distance of the earth from the sun, and at mean distance 1″ of arc amounts to 2,300 miles. Now owing to the great distance of the planet from the earth, the objects we see must have considerable size in order to be visible. I presume that the smallest object which has been observed for longitude or latitude is at least 2,000 miles in diameter. In the case of a line or streak one might be able to see with the aid of the modern telescope 0.1″ of arc in width, which on Jupiter would be 230 miles, but all the markings which have been observed are considerably greater in size than this minimum value. The ordinary spots we see on Jupiter, from which rotation time has been determined, have usually been upward of 3,000 miles in diameter, where the spot is circular or elliptical.

I began systematic observations on Jupiter in the year 1879, and these have been continued every year with the exception of the opposition of 1888 and a part of 1889, when the telescope was dismounted. I may say that, previous to this period, the observations of phenomena have usually been made by estimation. This was true with regard to the determination of longitude almost without exception, and very few positions in latitude have ever been determined with the micrometer. Amateur observers, who have no driving clock or micrometer, must necessarily rely on eye estimates for longitude and latitude, but when a telescope is equipped for micrometer work there is no better excuse for guessing than in the determination of the distance of a pair of double stars.

Sketches or drawings of the planet Jupiter are of very little value in the absence of other data. It is not unusual to find the latitude of conspicuous markings eight or ten degrees in error, and longitude a corresponding amount. At the beginning of my observations on Jupiter I decided to fix the size and position of all objects seen on the disk by

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micrometrical measurement. By such a system of procedure positive facts will be established, which in time may enable us correctly to interpret the complicated phenomena observed.

During the past twenty-five years the so-called canals and double canals on Mars have been the subject of much discussion. I believe if their position were fixed by micrometrical measurements, we should soon be able to decide what is real and what is imaginary.

In order to use the micrometer for measurements on a planet, it is necessary to know the size of the disk. Jupiter has been measured by many astronomers, both with the micrometer and with the heliometer, but the measurements made differ considerably, due to two causes. First, irradiation, which depends on the size of the telescope, or rather on the magnifying power employed. Second, the increased size of the image, due to the condition of the atmosphere. In the use of the heliometer the true irradiation may be eliminated, but not the increased size of the disk due to definition. In any case the measured size of the disk depends directly on the magnifying power employed.

In 1880 I made a series of measures of the polar and equatorial diameter of the planet with powers of 390 and 638, and in 1897 a series of measurements with powers of 390 and 925. In all cases, whatever the condition of the seeing, the lower power gave the larger diameter. From the measures made on six nights in 1897 when the seeing was good enough to be able to use a power of 925, the difference for the two powers employed was: polar, + 0.27″; equatorial, + 0.31″. In 1880 for ordinary seeing the difference for the two powers employed amounted to 1″. In order, therefore, to have some standard of size it would be necessary to decide upon the magnifying power employed with which the measures were made. Because of this apparent change in the size of the disk due to definition, to locate with precision any object on the surface of the disk, or a satellite off the disk, it is necessary to refer the object to both limbs of the planet at the time of observation. If the object is referred to only one

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limb, under unfavorable atmospheric conditions an error of 1″ of arc would be easily possible, but if it is referred to both limbs, then the effect of the irradiation, or enlargement of the disk, is almost wholly eliminated. In the reduction of my micrometrical work on Jupiter I have used the values 18.33″ and 19.48″ for the semi-axes of the planet at mean distance.

These values for the size of the disk were found from a great many differential measures made in 1880–'1 with a power of 390, and are somewhat larger than those given by the heliometer, owing to irradiation, but they will probably better satisfy micrometer work.

The observations for longitude, latitude and magnitude of objects on the planet Jupiter have all been made with the parallel-wire micrometer, preferably near the central meridian, but no rigid rule is followed in this respect. The longitude and latitude are usually determined whenever the spot or marking is wholly on the disk and distinctly visible.

The longitudes are measured by ascertaining the distance of the apparent center of the object from the limb of the planet, according to the method I pointed out some years ago. A determination of longitude or latitude generally consists of three bisections of the object and each limb of the planet. In the case of longitude, one-half of the difference of the distances at the mean of the times is the distance of the apparent center of the object from the central meridian on the visible disk. This method of determining longitudes has been found to be greatly superior, in point of accuracy, to the method of transits, as well as a great saving of time.

The error in measurement of objects on a luminous disk is about twice as great as that from the measurement of double stars of equal distance. The ordinary error for location of objects in latitude or longitude on the disk of Jupiter may be placed at about 0.25″ arc.

Twenty-five years ago it was almost the general opinion among astronomers that the phenomena seen on the planet Jupiter were transitory in their nature; that there was no permanency in the spots and markings, but that the aspect

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of the planet changed from day to day, and even at less intervals of time. Perhaps we shall get a better idea of what was known about the subject by quoting from Grant's "History of Physical Astronomy":

"Although generally there appear only three belts upon the disk of the planet, sometimes a greater variety is perceptible. Sometimes only one belt is visible. This is always the principal belt situated on the northern side of the planet's equator. On the other hand, its whole surface has occasionally been seen covered with belts. On the 18th of January, 1790, Sir William Herschel, having observed the planet with his forty-foot reflector, perceived two very dark belts dividing an equatorial zone of a yellowish color, and on each side of them were dark and bright bands alternating and continuous almost to the poles. A similar appearance was once noticed by Messier. These phenomena sometimes undergo very rapid transformations, affording thereby a strong proof that they owe their origin to the fluctuating movements of an elastic fluid enveloping the body of the planet. On the 13th of December, 1690, Cassini perceived five belts on the planet, two in the northern hemisphere and three in the southern hemisphere. An hour afterwards there appeared only two belts nearer the center and a feeble trace of the northern belt. The same astronomer frequently witnessed the formation of new belts on the planet in the course of one or two hours. The dark spots on the disk of the planet also afforded unequivocal indications of the existence of an atmosphere, for it is impossible to reconcile their variable velocity with the supposition of their being permanent spots adhering to the surface of the planet. Cassini found from his observations that the spots near the equator of the planet revolved with greater velocity than those more distant from it. Sir Wiliam Herschel found that the velocity sometimes underwent a sensible change in the course of a few days. He supposed the spots to be large congeries of cloud suspended in the atmosphere of the planet, and he ascribes their movements to the prevalence of winds on its surface which blow periodically in the same direction."

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Lardner, in his "Astronomy," says: "In a month or two the whole aspect of the disk may be changed."

In my annual report to the Chicago Astronomical Society for the year 1881, I stated that the phenomenon seen on the surface of Jupiter was of a more permanent character than had hitherto been believed to be the case.

In 1878 a large and conspicuous object known as the Great Red Spot was seen on the disk of Jupiter. It appears that this object was first noted on June 2, by Lohse, of Potsdam, but in looking up previous records we find a spot seen in the same locality by the ancient astronomers. In the years 1664-'6, a great red spot was observed by Hook and Cassini. It was situated one-third of the semi-diameter of the planet south of the equator in latitude 6″. Its diameter was about one-tenth the diameter of Jupiter, or about 8,000 miles. This spot appeared and vanished eight times between the years 1665 and 1708. From 1708 to 1713 it was invisible; the longest time of its continuing to be visible was three years, and the longest period of its disappearing was five years. Since its appearance in 1878 it has been visible with large telescopes during the whole period, but at times so faint that, except for the indentition in the equatorial belt, the spot, perhaps, would have been lost to astronomers, as it was formerly when they had smaller instruments.

The great red spot is 11.61″ or 37.2 degrees in length, and 3.87″ in breadth, or about 27,000 miles long, 9,000 miles broad, elliptical in outline, and, if we suppose the depth of the spot equal to its width, its volume would be about three times that of the earth. This object, which seems to have great permanency, is not stationary in either longitude or latitude.

It was visible in 1869 and 1870, when it was observed by Gledhill on four nights from November 14 to January 25, and on one night by Mayer. The data for ascertaining the rotation period have been derived from the drawings made, and necessarily are approximate.

The rotation period was $9^h\ 55^m\ 25.8^s$, or about eight seconds less than it was in 1879. From the observations made

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in 1878 I derived a rotation period of $9^h\ 55^m\ 33.7^s$. Since the rotation period had been increasing for twenty years, the observations in 1869 are of value in tracing the motions of this object.

I may add that Mr. W. F. Denning, who has compiled the observations of what is presumed to be the red spots from 1831 to 1899, finds a rotation period of $9^h\ 55^m\ 34^s$ between 1869 and 1878, by assuming the number of rotations between consecutive observations. But where the interval is five years and upwards this is a very unsafe method of procedure, as will be perceived from the motions which have been studied during the last twenty-three years.

From the measures which I have made every year I have determined the rotation period for the red spot from 1879 up to the present time, and with the minimum value in 1879 of $9^h\ 55^m\ 34^s$. The diagram shows the rotation period at any point between 1879 and the present time. The vertical lines are intervals of 400 days, one day more than the synodic period of the planet. The horizontal lines represent seconds or arc, so that the rotation period at any point will be shown on the curve, the seconds being at the left hand of the diagram, and the time at the bottom of the diagram. The rotations for this curve were computed for intervals of 400 days by using at each epoch about twelve normal places, and the probable error on the rotation period, as determined in this way, varies between $\pm$ 0.02 sec. and $\pm$ 0.07 sec. The curve is perfectly smooth for the first six years, showing that the motion of the spot was very regular. Since that period the curve is not absolutely smooth, which may be due to the faintness of the object, and the shifting of the center from which the measurements were made, when the measures were referred to the bay in the equatorial belt. My measures, when the spot was very indistinct, have been referred to the center of the bay, and that may account for the small irregularities in the curve during the later years. From the diagram it is seen that the rotation period of the planet reached its maximum between 1898 and 1899, being 41.7 seconds. Previous to 1898 the spot had an apparent retrograde motion

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on the disk of the planet, and since that time the spot apparently has come to rest, and now has a direct drift around the planet. The rotation period for the last 400-day interval is 39.75 seconds, but the actual period at the present time is about three seconds less than it was in 1898. From the inspection of this curve, taken in connection with the rotation period which I found for 1870, it would seem to require a long cycle to make the rotation period the same as it was in 1879. The dotted curve indicates the "mean" rotation period at any instant, counting from September 25, 1879. The "mean" period for the interval 1879 to 1902 is $9^h\ 55^m\ 39.93^s$.

In 1880, when the red spot was most conspicuous, it was seen, when brought on the disk by rotation, at 87 degrees of longitude, or $2^h\ 35^m$ in time from the central meridian, when its length was only second of arc. When the spot is wholly on the disk its longitude is 71.4 degrees and the apparent length 3.7″. It is possible that the rotation period may be connected with its visibility, viz., when the spot comes back to the same rotation period it had in 1879 it may become more conspicuous and reddish in color. This object has drifted in longitude about three and one-fourth times around the planet since 1879, assuming the rotation period at that time to be the true rotation period of the planet. It seems to me, however, more probable that the time of rotation of the planet is longer than any period hitherto determined, in which case all objects would drift in the same direction. The object also has a motion in latitude, and the total displacement in twenty-three years has been 1.7″, or about 4,000 miles drift in latitude. The rate of drift in longitude and the visibility may possibly be due to the greater or less submergence of the spot in the material which composes the surface of the planet.

The diagram shows the mean latitude of the red spot at each opposition corrected for the elevation of the earth above Jupiter's equator. It seems that during these twenty-three years the spot has approached nearly 1″ nearer the equator than it was in 1879. The short time scale, the vertical lines being intervals of 400 days, makes the dis-

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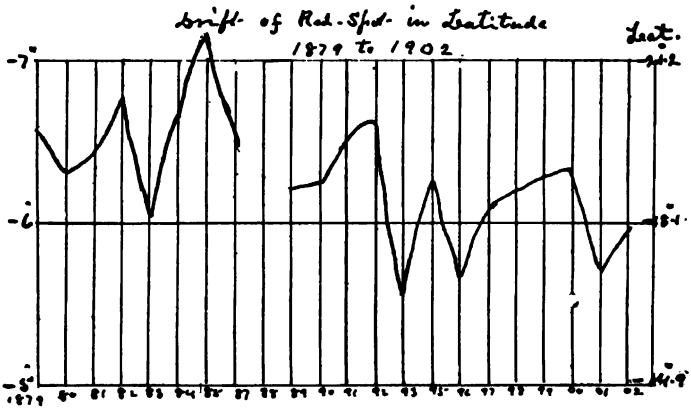
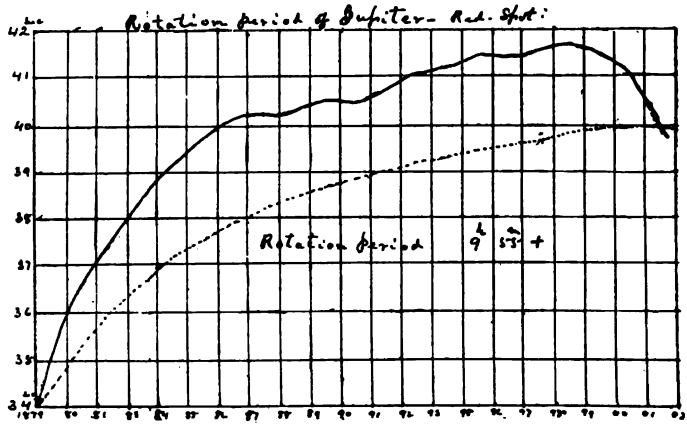
placement appear more abrupt than it really is. The Jovicentric latitude is given on the right hand of the diagram. At the present time this is about eighteen degrees. We might add that this displacement in latitude of the red spot is very much less than the displacement of the great equatorial belt.

The most conspicuous marking on the surface of the planet is the great equatorial belt, which is always visible. This belt may appear as one belt, but usually is composed of two portions lying on either side of the equator of the planet. In 1880 it was practically one belt extending without break for a short time across the surface of the equator. From the study of the changes in this belt one may arrive at some idea





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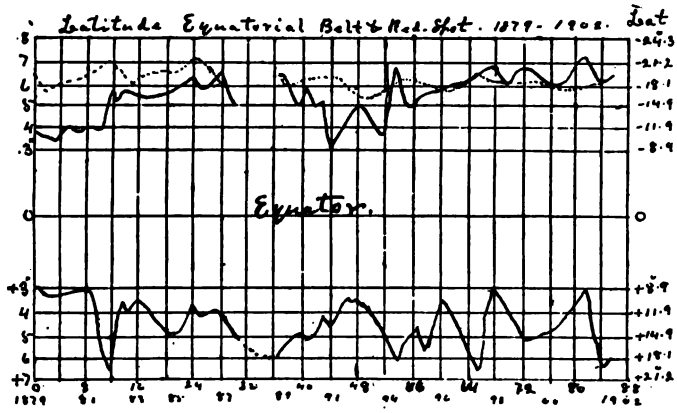

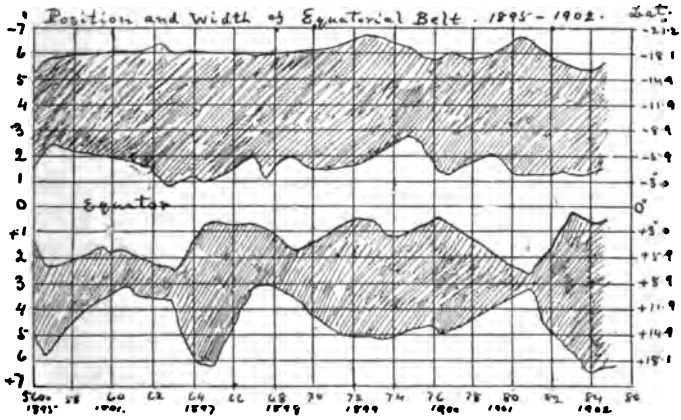

regarding motions taking place on the surface of the planet. The systematic determination of motion in latitude has never been undertaken by any one previous to the observations which I began in 1879. Occasionally latitudes have been measured during one opposition. Arago, in "Astronomé Populaire," raised the question whether the belts on Jupiter are fixed in size and position, and he gives some measures of the positions from 1811 to 1837, and takes the mean of these various measures for getting the mean position of the

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belts on the planet. These observations are approximate, and are used without regard to the position of the earth above and below Jupiter's equator. From 1879 to the present time the latitude and width of the great equatorial belt have been measured on nearly every observing night, so that we may ascertain the position of the edge of the belt at any instant. It is found that the north edge of the belt has had a drift in latitude of nearly 4″ of arc or 12 degrees, and the south edge about the same amount. The changes in the drift of the belt are usually slow and gradual, but it is possible sometimes that considerable change may be observed in the course of a few days. The diagram indicates the position of the edge of the belt from 1879 to 1902, and it is of very great interest in showing at a glance the changes that have taken place in latitude. From the study of this diagram it appears that the disturbances take place on both edges of the belt at practically the same time. The matter composing the belts generally has a motion on both sides of the equator in opposite directions.

In 1879 the whole width of the belt was about 7″ of arc. In 1882 it widened out and has at times reached a width of about 13″ of arc. The edges of the belt remain practically parallel to the equator in all longitudes. I have noticed two marked exceptions. On October 3, 1882, there was a curved projection in longitude plus 30 minutes, following the great red spot. On October 14 the edge was smooth at the same longitude and the whole belt had drifted so far north as to coalesce with B_3. Also on February 24, 1897, in longitude plus five hours, the preceding half of the north edge of the belt drifted about two seconds farther north than the following portion. On February 27, however, the edge of the belt was comparatively smooth in the same longitude.

Aside from the drift of the edges of the belt in latitude, the belt itself changes dimensions from time to time to a considerable extent, and these changes have been studied from micrometrical measurements since 1895. The diagram shows the width of the two portions of the equatorial belt at any instant from 1895 to 1902. The diagram indicates the width

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and not the shape of the belt at any time. Now it is seen, taking the portion of the belt north of the equator, at times it becomes very narrow; for instance, in 1896 it was about 1″ arc in width, 1897 it was about 5″ in width, and then it became narrower again in 1898, and continued wide from that time until 1901, when it was less than 1″ arc in width and appeared as a faint line on the planet. The south portion of the belt has not passed through so great change during the five years, and has been more steady in latitude and width. On either side of the equator are fainter belts which usually extend to 40 degrees of latitude as separate belts. These faint belts are subject to change, in both size and position, from year to year.

On the belts and on the surface of the planet there are frequently seen small spots, sometimes white and sometimes black, viz., 2,000 miles or more in diameter, and from the observations of these spots we have determined the rotation period of the planet for different parts of the surface. The spots, which appear near the north margin of the equatorial belt nearly every opposition are sometimes permanent for two or three years, and have a slight motion in latitude, only a fraction of 1″ of arc, whereas the belt may move 3″ or more in latitude in one year. It seems to me that this fact has an important bearing as to location of the objects, viz., the belt and the spots. I infer from the slight displacement of the spots that they lie at a lower level in the Jovian surface than the equatorial belt, and for the same reason the great red spot lies at a lower level.

The transits of the satellites of Jupiter offer phenomena which have a direct bearing on the constitution of the planet. The satellites at times cross all parts of the disk in transit. For a normal transit the satellite disappears at some distance from the disk after ingress and reappears at a similar distance before egress. From this fact it is concluded that the center of the disk of Jupiter has the same reflecting power as the satellites. With the 18½″ refractor I have ascertained that a satellite can be followed for a distance of 10″ of arc from the limb or nearly one-quarter the diameter of the disk

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before it disappears in transit. However, when the transit occurs within 10″ of the north or south limbs, the satellite can be seen during the entire transit across the disk. Now since the satellite is not supposed to be hot enough to give light, we conclude there is not sufficient heat in the planet to produce light. The observation of the eclipse of the satellite also shows that it has no inherent light of its own.

Aside from the period of $9^h\ 55^m$ some spots and markings give a shorter period of $9^h\ 50^m$, indicating that these objects have a motion of about 250 miles an hour in the direction of the planet's rotation, assuming that the true rotation period is $9^h\ 55^m$. For mechanical reasons the spots which give this shorter period must necessarily be located above the spots which give the longer period of $9^h\ 55^m$. From 1879 to 1885 two white spots in latitude 6 degrees south were observed every year, giving a rotation period of $9^h\ 30^m$ plus. The white spots, during the last twenty years, which give the short period, have been observed between the latitudes plus 11 and minus 8, and also in one year, in 1891, black spots which gave a short period were observed in latitude 20 degrees north. The spots and markings which give the long period of $9^h\ 55^m$ have been observed in latitudes between 37 degrees north and 38 degrees south and within 12 degrees of the equator.

The equatorial belt sometimes approaches the equator very closely, and its rotation for some years has been the same as that of the great red spot, for the spot and the belt have, as we know, maintained the same position toward each other. Hence we find the longer rotation period of $9^h\ 55^m$ in precisely the same latitude as the shorter period. On examining the table of rotations there does not seem to be any connection between latitude and rotation period, as has often been alleged. The longest period which I observed, covering an interval of 156 days, is $9^h\ 56^m\ 0.4^s$, which was in latitude 26 degrees north.

Mr. A. S. Williams has written some articles on the rotation of the surface of Jupiter in which he finds zones of constant currents. These speculations are not sound, for the reason that

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in the same latitude we find different rotation periods for the same instant of time, and, as I have said before there is no law connecting rotation period with the latitude, except we find this period of $9^h\ 50^m$ more commonly between the limits of -8 and $+11$ degrees, whereas the longer period is distributed indiscriminately over the surface of the whole planet as far as 38 degrees latitude.

The question has sometimes been raised as to whether the phenomena on Jupiter were periodic. The inclination of Jupiter's equator to its orbit being only three degrees, any periodicity due to the revolution of Jupiter around the sun should recur at intervals of about twelve years, but from the motions which I have shown for the displacement of the belts, in latitude there does not seem to be any regularity in the period. I presume any periodicity is of the same nature as we have in the meteorology of the earth. We have, of course, a sequence in the seasons and a sequence in weather conditions, but our sequence in weather conditions does not follow any regularity, and if changes on Jupiter are due to meteorological causes, we should not expect to find any definite period.

The application of photography to astronomical observations has been of great value in various directions, but up to the present time it has been of no benefit in the study of planetary details. Photographs of the planet Jupiter have been made since 1880 at different times, but they only show the simple outline and some of the conspicuous markings. The scale of photograph is so small that it cannot be used with any degree of success for determining position on the disk. There is no question, however, that if we are ever able, by increasing the sensitiveness of our plate, to make an enlarged photograph of Jupiter or Mars, such as is seen through the telescope with the eye, it would be a great advance, and it would enable us to decide very many questions which are now impossible owing to the limited time that we are able to study the object under consideration, due to the rapid motion of the planet on its axis. The phenomena seen on the planet depend in a great measure on the size

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of the telescope and the magnifying power employed. In my work on Jupiter I have habitually used a power of 390, which is adapted to most conditions for seeing and will show minute detail. With the same telescope, using a power of 190, the appearance of the disk is quite different, and minute detail cannot be seen with distinctness. The observers who have small telescopes of five or six inches in aperture and use a comparatively low power do not see the phenomena as they would be shown by larger telescopes and high power. Hence in any question of disagreement observation with the small telescope should have very little weight. The principle is precisely the same as in the observation of double stars. While a pair of close or unequal double stars may be easy objects for 18½″ object glass, they are entirely beyond the range of a 6″ object glass.

A misinterpretation of phenomena has given rise to very erroneous notions regarding the changes which take place on the surface of the planet. When we look at the planet Jupiter, we see only about one-fifth of the surface in longitude distinctly at any one time, and hence in the course of two hours we should have an entirely new set of features under view of the eye of the observer. The faint belts north and south of the equator sometimes only extend over a portion of the circumference of the planet, and in such case one might see a greater or less number of belts after the interval of two hours or more, as has been stated by Cassini and others.

My observations during the past twenty-three years have established the following facts:

1. The equatorial belt changes in both size and position to a considerable extent, but these changes are usually slow and gradual. Occasionally, however, a marked change may be observed in the features of the belt in the course of a number of days.

2. The fainter belts also are displaced in latitude and in the amount of material of which they are composed. The visibility of the fainter markings and spots depends in a considerable measure on the distance of the planet from the earth. When the planet is at more than mean distance, the

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so-called polar belts are very faint and sometimes invisible, even with a large telescope, and are not brought into view until the planet approaches toward opposition. This fact I noticed particularly in the early years of my observation on Jupiter, when the observations were made as near the sun as possible.

3. The egg-shaped white spots, which appear in this form from perspective, as they are probably nearly circular, are found both north and south of the equator and are very permanent in latitude. They are usually from one to two seconds of arc in diameter. These spots are not fixed with regard to each other, even when they are located in the same latitude.

4. Aside from the white spots, there are dark spots of similar size, sometimes on the faint belts and sometimes entirely disconnected from the belt. The dark matter is not as stable as the egg-shaped white spots, and probably lies at the same level as the equatorial belt.

5. Near the equator are found white spots, usually of a larger size and more irregular in shape, which give rise to the period of $9^h\ 50^m$.

The mean density of the planet Jupiter is 1.37 times that of water. The spheroidal figure of the planet indicates that the density increases as we proceed from the surface to the center. In the case of the earth the density at the surface is about one-third the mean density, and assuming the same rule for Jupiter, its surface density would be 0.4 to 0.5 that of water. The liquefaction of air and gases during recent years enables us to imagine a medium which would have the density corresponding to that of the surface of the planet. The older astronomers, of course, had no knowledge of any substance between atmosphere and liquid, and hence, in forming their theories of the motions on the surface of the planet, the theory was necessarily atmospheric, but there is now no excuse for maintaining an atmospheric theory which will not account for the phenomena observed.

A probable theory of the constitution of the planet should in some degree satisfy all the phenomena observed. No

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one can draw legitimate conclusions from casual observations. On the surface of Jupiter we find the following objects: (1) The great red spot, which is the most stable of all objects seen on the disk of the planet. During the period that its size has been measured with the micrometer one cannot say with certainty that there has been any change in its size or shape from 1879 to 1902. It is now conceded by astronomers that the object is identical with the spot observed by early astronomers. Such being the case, it would seem to be absurd to say that anything in the nature of a cloud should persist in the same form for more than 200 years. Its spheroidal shape in connection with its stability would seem to show that it has volume and mass. Its motion in latitude, as we have already seen, is much less than for the equatorial belt. The matter of which it is composed is in a different condition to that of the belt. In 1880 I had the good fortune to notice the transit of a satellite over the red spot. The satellite, which was invisible during transit, when projected on the spot appeared as bright as when off the disk. On the contrary, when satellites transit the belt they are invisible. (2) Egg-shaped white spots from 2,000 to 5,000 miles in diameter. These spots I have found in north latitude 13 to 37 degrees and in south latitude from 18 to 27 degrees. These objects do not look like clouds, and so far as we know they do not change their shape during the six months while under observation. They are also very stable in latitude and give a rotation period of $9^h\ 55^m +$. (3) Small black spots seen on the belts or entirely separate. These objects give a rotation period of $9^h\ 55^m +$, but on one occasion in latitude 20 degrees north I found a short period. (4) The dark matter forming the system of belts including the equatorial belt and the so-called polar belts, which also give a rotation period of $9^h\ 55^m$. (5) The white spots which give a rotation period of $9^h\ 50^m$.

It seems to be the opinion of most writers on Jovian phenomena that the planet is yet at a high temperature, but not self-luminous. The high temperature is favorable for the explanation of some of the phenomena observed. I have

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long held the opinion that a simple atmospheric theory was not sufficient. The greater luminosity of the centre of the disk indicates absorption of light, probably due to an extensive atmosphere. The white spots which give a rotation period of $9^h\ 50^m$ are of different form and size from the egg-shaped spots which give the period of $9^h\ 55^m+$. The short period spots are greater in size and irregular in shape, sometimes appearing simply as a rift in the equatorial belt. Having these facts before us, we can formulate a theory which will fairly well satisfy all classes of phenomena.

I assume that the visible boundary of Jupiter has a density of about one-half that of water. This medium is in the nature of a liquid; in it are located the great red spot and the egg-shaped white spots. In such a medium all motions in longitude and latitude would be slow and gradual, and the shape and size of the object would have great permanency. The equatorial belt and the so-called polar belts may be located on the surface or at a higher level than the red spot. In the middle latitude within twenty degrees of the equator the higher atmosphere carries a layer of dark matter in the direction of the rotation of the planet at a velocity of about 250 miles per hour, making a complete circuit around the planet in 44 days. In this envelope are formed the openings which we call white spots and, by unequal distribution, black spots. The great bay in the south edge of the equatorial belt may be accounted for by assuming that the great red spot is at a lower temperature than the medium in which it floats, and by its lower temperature, condensing a portion of the vapor composing the belt. In 1882, when the edge of the belt drifted south, it did not come in contact with the spot at any point, although it advanced at times beyond the center. In 1883 I stated that the spot seemed to have a repelling influence on the belt. During the past twenty years, when the belt and the spot were in proximity a depression was formed in the belt directly opposite, which was of the same form as the contour of the spot. The belts may be assumed to be some sort of vapor of considerable density. The cloudlike matter, which in the equatorial

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regions is moving over the surface at the rate of 250 miles per hour, would account for the minor changes on the surface of the equatorial belt. I think the theory I have given offers a more plausible explanation of the various phenomena observed than the off-hand statement that we see simply clouds floating in the atmosphere of the planet.

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[The following papers were read before the Astronomical and Astrophysical Society of America, and Section A, in joint session.]

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PERIODIC SOLUTIONS OF THE PROBLEM OF FOUR BODIES. BY E. O. LOVETT.

ON THE INTEGRALS OF THE PROBLEM OF n BODIES. BY E. O. LOVETT.

ON CERTAIN MATTERS CONNECTED WITH SPECTROSCOPIC METHODS. BY W. J. HUMPHREYS.

THE SPECTRA OF STARS OF SECCHI'S FOURTH TYPE. BY GEORGE E. HALE, FERDINAND ELLERMAN AND J. A. PARKHURST.

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On Certain Spectrum Bands. By W. J. Humphreys.

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FORM AND STRUCTURE OF THE GALAXY. BY F. W. VERY.

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ON AN AUTOMATIC DEVICE TO FORESTALL THE DEWING OF OBJECTIVES AND MIRRORS. BY D. P. TODD.

ON A HIGHLY FAVORABLE TYPE OF INSTRUMENT FOR PHOTOGRAPHING THE SOLAR CORONA. BY D. P. TODD.

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IMPROVEMENT IN THE MOUNTING OF FIXED MERIDIAN INSTRUMENTS. BY G. W. HOUGH.

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STATEMENT OF THE PROGRESS MADE BY THE WATSON TRUSTEES IN COMPUTING TABLES OF THE ASTEROIDS DISCOVERED BY JAMES C. WATSON. BY SIMON NEWCOMB.

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ADDRESS

BY

W. S. FRANKLIN,

VICE-PRESIDENT AND CHAIRMAN OF SECTION B FOR 1902.

POPULAR SCIENCE.

LADIES AND GENTLEMEN: Five years ago I prepared a sketch of an address which I expected to deliver as retiring president of the Iowa Academy of Science. I was not able to deliver the address, however, on account of enforced absence from the Des Moines meeting of the Academy at Christmas time, 1897. It was my intention in that address to speak in terms of commendation of some of the ideas advanced by Professor Woodrow Wilson in his then recent address given on the occasion of the Sesqui-centennial celebration of Princeton University. Professor Wilson's recent promotion to the presidency of Princeton University has called his Sesqui-centennial address again to our minds, and it seems to me that I may very properly say now what I had intended to say in 1897, especially inasmuch as no one, speaking for science, has expressed any degree of sympathy with President Wilson's point of view. I hope to make my meaning so clear and definite as to render it unnecessary for me to limit or qualify my general expression of sympathy with Professor Wilson; although the words he has used in his Sesqui-centennial address are certainly open to an interpretation which no seriously minded man of science could possibly accept.

In order that we may enter upon this subject with some degree of mutual understanding I think it is necessary to quote President Wilson at some length. He says, "I am much mistaken if the scientific spirit of the age is not doing

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us a great disservice, working in us a certain great degeneracy. Science has bred in us a spirit of experiment and a contempt for the past, * * *" yet "I have no indictment against what science has done. I have only a warning to utter against the atmosphere which has stolen from our laboratories into lecture rooms and into the general air of the world at large. * * *" Science "has driven mystery out of the universe; it has made malleable stuff out of the hard world and laid it out in its elements upon the table of every class room. Its own masters have known its limitations; they have stopped short at the confines of the physical universe; they have declined to reckon with spirit or with the stuffs of the mind, have eschewed sense and confined themselves to sensation. But their work has been so stupendous that all other men of all other studies have been set staring at their methods, imitating their ways of thought, ogling their results. Let me say once more, this is not the fault of the scientist; he has done his work with an intelligence and success which cannot be too much admired. It is the work of the noxious and intoxicating gas, which has somehow got into the lungs of the rest of us from out of the crevices of his workshops—a gas it would seem, which forms only in the outer air, and where men do not know the right use of their lungs. * * *" "We have not given science too big a place in our education, but we have made a perilous mistake in giving it too great a preponderance in method over every other branch of study. We must make the humanities human again; we must recall what manner of men we are; must turn back once more to the region of practicable ideals. * * *" "I should fear nothing," says President Wilson, "better than utter destruction from a revolution conceived and led in the scientific spirit."

The chief obstacle to me in my attempt to reach a satisfactory appreciation of President Wilson's point of view lies in his apparently loose and unguarded use of the term "scientific spirit." If he means by it that humble spirit of inquiry based upon systematic methods of analysis which are really applicable to the nature of the inquiry, I certainly

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cannot agree with him that it can do any disservice or that it would be anything but a basis of hope as the ruling element in a revolution. I do not believe that President Wilson entertains any such idea. If he means, however, to signify by "scientific spirit" that widespread and portentous "neglect of the essential qualities in things," I most certainly approve his meaning and share his feelings of distress, although I disapprove his mode of expression.

Scientific men are of course not entirely free from this neglect of the essential qualities in things, but I think that the chief neglect lies in the general popular imagination, and I believe that the growth of modern science and the resulting transformations of our material world, have brought upon us an acute and distressing manifestation of it. Inasmuch as I intend to speak to you mainly of the nature and extent of the influence of scientific work on the popular imagination, I may claim to speak on popular science.

We cannot discuss intelligently any subordinate manifestation of science until we come to some mutual understanding as to what science itself is; but I must confess that I do not like to go to the extent of defining a thing which, in my own mind at least, is so severely plain and humble. I do not know how you feel, but for my part I am sick of this disgusting din which has been increasing for a hundred years in canting praise of science, a din which I can most easily specify to your perception by saying that my reluctance to define science is chiefly the fear that a pack of popular idiots will rise up with indiscriminate shouting and say—you know, of course, that I have endless choice of ridiculous sayings of influential men in needless and foolish praise of science to quote from! Science does not need praise, nor does work need praise; they both need plain wages. I think it is time to urge a definition of science which will help to purge the popular imagination Science is the spirit of work. I do not mean the spirit of a man who works, but I do mean simply that science has to do solely with the increasing efficacy of the sweaty labor of this world. I am little disposed to argue what many of you may be inclined to

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think an undue narrowness in this definition, but I assure you that it is wide enough for me. "An affected thinker," says Ruskin, "who supposes his thinking of any other importance than as it tends to work is about the vainest kind of person that can be found" among busy men.

My own knowledge of science rests partly on anticipation and partly on a college and university experience more than usually varied, and I am convinced that science is "primarily concerned with the making of breeches," although, of course, you know and I know many things not now applicable to that useful, or in some cases it may be useless, business. Perhaps one who is chiefly engaged in technical education is prone to accept that practical view, yet one should not, I think, attempt to escape the evidence of one's experience, the less so, indeed, the more intimately his experience is related to practical affairs, and in any case one should only strive against exaggerated inference and extravagant conclusion.

I trust that the granting of my contention as to the severe and unpretentious homeliness of science may not divest it in your minds of a bloom which you deem essential to your interest in it; but however that may be, an understanding of what I have to say demands that much of you.

I am inclined to look upon science as a servant, and I have no sympathy for that state of mind which is exemplified by two extreme types; the man of alleged general culture who has so far forgotten his manhood as to be lost in vacant, staring wonder at the material results of modern science, but who remains in either lazy or stupid ignorance of the underlying method, and the specialist who sighs for those good old days when one man's mind might compass the entire range of scientific activity. This second type is a man who errs mainly in false humility, and I am reminded in this connection of the character of Wagner in Goethe's Faust, second part, who humiliates himself before a creature of his own devising, the Homonculus. I take it to be self-evident that science can never transcend the intellectual grasp of a single man. Of course we must remember that as in case of a large in-

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dustrial establishment there are many details which cannot be carried forward by the superintendent alone, so in science there are many special details which cannot be carried forward by one person, but if we consider rightly, I think it must appear that these details are essentially not intellectual.

Concerning those whose interest in science is based upon its results, I think you will agree with me that no intelligent interest can be so founded. Everything that appears in the name of science in our newspapers and magazines relates only to results. Have any of you seen in our newspapers or popular magazines any detailed description of the principles and methods used by Marconi in his wireless telegraphy? I think you have not, and yet we know too well that there is not a newspaper reader in the country but imagines he has an idea of wireless telegraphy simply because he has read that Marconi has signaled across the Atlantic Ocean.

I am somewhat intimately connected with the teaching of electrical engineering, more intimately, perhaps, than my chief interests warrant, and I frequently have occasion to speak with non-technical men respecting this subject. There are, indeed, many plain men who keep their senses when they speak of the developments in applied electricity and who talk with some degree of rudimentary intelligence concerning these things, but there are many, very many, more who seem to imagine that the glad comfort with which they ride in a trolley car constitutes an intelligent interest in science and has an intellectual quality!

True interest in science begins when one gets an idea into one's head and sees its firm and unequivocal application to external fact, and the characteristic feature of the study of science is a *determining objective constraint upon the processes of the mind.* I am surprised that this one important feature of science study is never mentioned in the many estimates that have been made of the value of science study in education, for as a matter of fact that complete definiteness which is usually urged as the characteristic feature of science study is the fundamental condition of every psychological process;

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you say this or you say that; you go or you do not go; and the psychological processes which play in the study of science do not differ from other psychological processes in this respect, absolutely not at all.

Let me illustrate this objective character of science study by an example which happens also to illustrate an error which I suppose many of you entertain. What is the definition of the mass of a body? The careless and imaginative definition which is usually given is that "the mass of a body is the quantity of matter the body contains." I suppose that definition satisfies many of you, but it does not satisfy me. All our notions of length and angle take their rise in and are fixed or defined by those fundamental geometric operations of congruence. The real definition of mass is no less a physical operation, the verbal definition is the briefest possible specification of this operation and it can be nothing else; the result of this operation on a given body is an invariant number, and by a feat of the imagination we conceive this invariant number to be a measure of the quantity of matter the body contains. Ask a farmer's boy how he would define or set the boundaries to a cow pasture, explaining to him that you seek real practical information, and I think he could only answer, by building a fence around it! Most of our definitions in physics which apply to sensible things are necessarily applied to ideally simplified conditions which cannot be feasibly realized as actual operations, all for the sake of simplicity and directness of statement, and the consequence is, I think, that many of us lose sight of the fact that these definitions are in reality operations.

I sometimes think that no popular scientific writings should be tolerated which do not introduce the reader to some appreciation of the exacting requirements of successful work. Some of Jules Verne's stories, for example, are peculiarly faulty in this respect, and these stories, and many others like them, are largely responsible, in my opinion, for the widespread fancied interest in science on the part of those who really care only for its immediate results. Most persons are fascinated by Jules Verne's careless trip to the

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moon and by the easy improvidence of his ten thousand leagues under the sea.

A short time ago I had occasion to review a little book in the pages of Science, and I found therein an opportunity to briefly state what in my mind is a more serious perversion of science than that which is presented by those whose fancied interest in it is based on its results, and who, poor fools, invest in Keeley motors and sea gold companies because, forsooth, the desired result is so clearly evident. Surely one cannot hold the "scientific spirit" accountable for "great degeneracies" like these. The book in question purports to treat of the atomic theory; it is prefaced by an introduction by a professor in the University of Chicago, and it deserves a place in DeMorgan's "Budget of Paradoxes." I mentioned in my review, to begin with, a list of headings to serve to indicate to the general reader the present scope of the atomic theory; the atomic theory of gases, the theory of crystal structure, the molecular theory of elasticity, the electro-atomic theory of radiation, the corpuscular theory of the electric discharge and of the electric current, stereochemistry, and the like, and I expressed it as my conviction that neither the author nor his introducer knew even a little of these things.

When I take up a book like the one under consideration I am always impelled to ask myself the question, What are atoms? although in studying ordinary books on physical science the question never forcibly occurs to me. In so far as we have anything really to do with atoms, I believe they are mere logical constructions. Bacon long ago listed in his quaint way the things which seemed to him most needful for the advancement of learning. Among other things he mentioned "A New Engine, or a help to the mind corresponding to tools for the hand," and I think that the greatest achievement of the nineteenth century in the physical sciences is the realization of Bacon's idea in a great body of useful theory. Helmholtz says: "It is a great advantage for the sure understanding of abstractions if one seeks to make of them the most concrete possible pictures, even when the doing so brings

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in many an assumption that is not exactly necessary." Just how much of this useful theory is to become the common property of all men it is impossible to say. For the theory is by no means fixed and may not be for a century to come, and no one but the most determined specialist can be expected to appropriate and use the more complex theories which depend upon the keenest mechanical sense, the sharpest algebraic faculty, the strongest geometrical imagination, and the most devoted study; but there is a great and growing body of simple conception and theory which can and does represent to the understanding a vast array of fact.

This New Engine, as Bacon calls it, is a necessity to every man in so far as its state of perfection and the limited opportunity for education permits, and on these two conditions no one need fear any serious clogging of men's minds by it. Many scientists do not, however, fully realize, I think, that the great majority of men do not have and should not have any interest, or at least they should not expend their energies, in those border regions of science where uncertainty and obscurity necessarily and prevailingly obtain. The failure of a specialist to realize the remoteness of his work from legitimate popular interest often results in his endeavor to capture the popular imagination by sensational announcements of which we see only too many examples. The fact is that specialization in science requires a degree of renunciation, and to the extent that this requirement is not met by scientists they do a disservice to their fellow men. I believe indeed that no man can do honest and effective work as a specialist and fail to meet this fundamental requirement; and the disservice that accrues when he attempts to evade it is illustrated most distressingly by that would-be electro-scientist who has recently telegraphed to Mars!

A career in which one could come into sympathetic touch with great numbers of men would be very satisfactory to most of us, no doubt, but the career of the scientific specialist is not such, and I can not refrain from stating it as my conviction that a sufficiently guarded appropriation of say, ten per cent. of the income of the Carnegie endowment for

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furthering the personal intercourse of scientific specialists would be productive of greater results by far than could possibly be effected by the expenditure of the remaining ninety per cent. in any other way whatever. I say this more particularly from the point of view of the western man.

I think, with President Wilson, that scientists have, as a rule, recognized the limitations of their work, and I certainly think, also, that other men err in attributing to science too great an extensity and in failing to reach any just appreciation of the intensity of science. Every one should know that a specialist's idea of a thing, such as a gas, an electric current, or a beam of light, comes very near to being a working model of the thing. The elements out of which such models are made are purely notional, and although the specialist habitually speaks of them in objective terms for the sake of concreteness and clearness, it is of the utmost importance that the thought be chiefly directed to the physical facts which are represented and not to the models themselves. "Our method," says Bacon, "is continually to dwell among things soberly, without abstracting or setting the mind farther from them than makes their images meet," and "The capital precept for the whole undertaking is that the eye of the mind be never taken off from things themselves, but receive their images as they truly are, and God forbid that we should ever offer the dreams of fancy for a model of the world."

There is a tendency among reflecting men to confuse the boundaries between our logical constructions and the objective realms which they represent to the understanding. Münsterberg thinks that this is the gravest danger of our time. I do not fully agree with this, but I do agree with President Wilson in seeing in this confusion of boundaries the effects of a noxious gas which has somehow got into the lungs of other men from out of the crevices of our workshops, a gas, it would seem, which forms only in the outer air and where men do not know the right use of their lungs.

This confusion of boundaries is, to my mind, a new species of idolatry. The old idolatry is the worship of form, and this new idolatry is that contemplation of our logical construc-

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tions which despises objective constraint. Now, I cannot see that we as scientists are in any degree responsible for this disservice, this working of a great degeneracy among men, but as individuals I think most of us are guilty of more or less frequent and flagrant lapses of that submission to objective constraint which is the very essence of moral quality in scientific work.

An amusing collection of instances of this new idolatry, which we all know is not so very new after all, is given by DeMorgan in his "Budget of Paradoxes." There are many more of these paradoxes, to use DeMorgan's word for those unconstrained flights of the scientific imagination, in the mathematical and physical sciences than in biology. The explanation of this fact is, I think, that the logical structures of those sciences are to a great extent concrete in character so that even strong minds may lose sight of the boundaries between the realms of the mind and the realms of objective reality. The wide difference between the logical structures of physics and of biology may be further illustrated if I mention that I have long been impressed with the fact that the most satisfactory specialist to talk with is the biologist. His knowledge is not represented to his understanding by a mathematical-mechanical system of conceptions, but it approaches art in its close association with external form. Conversation with a physicist is, however, very like looking into the mechanism of a Mergenthaler type-casting machine, with the machine out of sight; a thing which is feasible enough among designers and builders, but scarcely a satisfactory basis for the flow of thought when one party in the conversation happens to be unfamiliar with and perhaps not interested in the mechanism in question.

Having so far expressed a degree of sympathy with President Wilson in the distress which some of the results of science, direct or indirect, have given him, I wish to say that giving the words of his sesqui-centennial address their most sinister interpretation a modern man would infer that President Wilson is inclined to turn back to the hope of a revival of classical and cloistered erudition as the chief end of

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learning. Now, I think that many of us feel that science itself is threatened by just this sort of thing in its own field. Many of us in fact know so much of the partial knowledges that have been reached during the century that we are deterred from effective work. "We advise all men," says Bacon, "to think of the true ends of knowledge, and that they endeavor not after it for curiosity, contention, or the sake of despising others, nor yet for profit, reputation, power, or any such inferior consideration, but solely for the occasions and uses of life."

Above all I believe it to be in general a perverting thing to use the elements and results of science as a basis of metaphysical speculation. "I believe," with Ruskin, "that Metaphysicians and Philosophers are, on the whole, the greatest troubles the world has got to deal with; and that, while a tyrant or bad man is of some use in teaching people submission or indignation, and a thoroughly idle man is only harmful in setting an idle example, and communicating to other lazy people his own lazy misunderstandings, busy metaphysicians are always entangling good and active people and weaving cobwebs among the finest wheels of the world's business; and are as much as possible by all prudent persons to be brushed aside like spiders."

There is, of course, a legitimate sphere of scientific speculation of a certain kind, but the purely suggestive and highly tentative efforts in this line should not be confused with the more substantial work of science, and this is precisely what happens in the popular imagination. The majority of men do not appreciate the difference between a discussion of the motion of stars in the line of sight based upon spectroscopic measurements and a discussion of the habitation of Mars based on nothing at all! Idle speculation is the last infirmity of strong minds, but it is certainly the first infirmity of weak ones, and popular science is, I think, primarily speculation.

The extent to which some of our elementary text-books in physics indulge in weak phases of speculation is very surprising to me, for in this connection it is absolutely out of

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place and entirely misleading. What do you think, for example, of the following quotation from Maxwell as a help to clear up an inadequate definition of energy in a secondary school book in physics? "We are acquainted with matter only as that which may have energy imparted to it from other matter, and which may in its turn communicate its energy to other matter. Energy, on the other hand, we know only as that which in all natural phenomena is continually passing from one portion of matter to another." What do you think of the following from an elementary English text-book? "The fundamental property of matter, which distinguishes it from the only other real thing in the universe, is inertia. * * * We are now in a position to give one or two provisional definitions of matter—provisional because we cannot yet say, possibly may never be able to say, what matter really is. It may be defined in terms of any of its distinctive characteristics. We may say that matter is that which possesses inertia, or again since we have no knowledge of energy except in association with matter, we may assert that matter is the Vehicle of Energy." I wonder if any of you really doubt that every notion in physics, definite or indefinite, is associated with and derived from a physical operation, and that absolutely the only way to teach physics to young men is to direct their attention to that marvelous series of determining operations which bring to light those one-to-one correspondences which constitute the abstract facts of physical science. If you do, I am bound to say I do not think much of your knowledge or teaching of physics. I think that the sickliest notion of physics, even if a student gets it, is that it is "the science of masses, molecules and the ether." And I think that the healthiest notion, even if a student does not wholly get it, is that physics is the science of the ways of taking hold of bodies and pushing them!

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PAPERS READ.

THE SEMIDIURNAL PERIODS IN THE EARTH'S ATMOSPHERE. BY FRANK H. BIGELOW.

THE CONSTRUCTION OF A SENSITIVE GALVANOMETER. BY C. G. ABBOTT AND S. P. LANGLEY.

THE CONDITION GOVERNING THE COHERENCE OF METALS WHEN THERE IS AN ELECTRICAL DISCHARGE BETWEEN THEM. BY CARL KINSLEY.

A DETERMINATION OF THE FREQUENCY OF ALTERNATING CURRENTS BY THE AUTOMATIC ADJUSTMENT OF THE CIRCUIT TO RESONANCE. BY CARL KINSLEY.

ON METHODS OF MEASURING RADIANT EFFICIENCY. BY E. L. NICHOLS AND W. W. COBLENTZ.

THE INFRA-RED EMISSION SPECTRUM OF THE MERCURY ARC. BY W. W. COBLENTZ AND W. C. GEER.

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DERIVATION OF EQUATION OF DECAYING SOUND IN A ROOM, AND DEFINITION OF OPEN WINDOW EQUIVALENT OF ABSORBING POWER OF THE ROOM. BY W. S. FRANKLIN.

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On the Velocity of Light as Affected by Motion through the Ether. By Edward W. Morley and Dayton C. Miller.

Some Measures of the Speed of Photographic Shutters. By Edward W. Morley and Dayton C. Miller.

On the Distribution of Pressure around Spheres in a Viscous Fluid. By S. R. Cook.

A Portable Apparatus for the Measurement of Sound. By A. G. Webster.

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Some Relations Between Science and the Patent System. By Charles K. Wead.

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Preliminary Report on an Absolute Measurement of the E. M. F. of the Cadmium Cell. By Henry S. Carhart and Karl E. Guthe.

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THE CHARACTERISTIC ABSORPTION CURVES OF THE PERMANGANATES. BY B. E. MOORE.

THE MAGNETIC ROTARY DISPERSION OF SOLUTIONS OF ANOMALOUS DISPERSIVE SUBSTANCES. BY F. J. BATES.

THE INVESTIGATION OF THE ATMOSPHERIC CIRCULATION IN THE TROPICS. BY A. L. ROTCH.

ANOMALOUS DISPERSION AND SELECTIVE ABSORPTION OF FUCHSIN. BY WM. B. CARTMEL.

THE CHANGE OF VOLUME IN CLARK AND CADMIUM CELLS DUE TO PRESSURE AND ITS RELATION TO ELECTROMOTIVE FORCE. BY ROLLA R. RAMSAY.

THE COEFFICIENT OF EXPANSION OF SOME ALLOYS OF NICKEL AND CAST IRON. BY THEO. M. FOCKE.

ONE SEVENTY-FIFTH INCH MICROSCOPE OBJECTIVE; AMERICAN MADE, BY ROBERT B. TOLLES. BY EPHRAIM CUTTER.

SULPHUR DIOXIDE AND THE BINARY-VAPOR ENGINE. BY R. H. THURSTON.

OBSERVATIONS ON THE CAUSE OF THE ROLLERS AND DOUBLE ROLLERS AT THE ISLAND OF ASCENSION. BY CLEVELAND ABBE.

STRAINS IN ROCKS. BY C. R. VAN HISE.

A NEW APPARATUS FOR DEMONSTRATING WAVE MOTION. BY FRED. J. HILLIG.

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DEMONSTRATION OF A PORTABLE HIGH TENSION COIL AND OZONE GENERATOR. BY G. LENOX CURTIS.

MOTION OF TRANSLATION OF A GAS IN A VACUUM. BY PETER FIREMAN.

[The following papers were read before the American Physical Society and Section B in joint session:]

RESULTS OF COMPARISONS OF MAGNETIC INSTRUMENTS. BY L. A. BAUER.

THE PRESSURE DUE TO RADIATION (FINAL RESULTS.) BY E. F. NICHOLS AND G. F. HULL.

IS THERE A SOUTHERLY DEVIATION OF FALLING BODIES? BY EDWIN H. HALL.

ELASTICITY OF COPPER AND STEEL AT —186° C. BY J. R. BENTON.

THERMODYNAMIC FORMULÆ FOR ISOTROPIC SOLIDS SUBJECT TO TENSION. BY J. R. BENTON.

EXPERIMENTS IN CONNECTION WITH FRICTION BETWEEN SOLIDS AND LIQUIDS. BY J. R. BENTON.

THE HEAT OF VAPORIZATION OF OXYGEN AND NITROGEN. BY J. S. SHEARER.

A SENSITIVE ACETYLENE FLAME. BY G. W. STEWART.

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THE MAGNETIC AND ELECTRIC DEVIATION OF THE EASILY ABSORBED RAYS FROM RADIUM. BY E. RUTHERFORD.

A PENETRATING RADIATION FROM THE EARTH'S SURFACE. BY E. RUTHERFORD AND H. L. COOK.

INDUCED RADIOACTIVITY EXCITED AT THE FOOT OF WATER FALLS. BY J. C. MCLENNAN.

RADIOACTIVITY OF FRESHLY FALLEN SNOW. BY S. J. ALLEN.

NOTE ON THE POSSIBLE CAUSE OF RADIOACTIVITY. BY CARL BARUS.

ON THE MECHANICAL EFFICIENCY OF MUSICAL INSTRUMENTS IN PRODUCING SOUND. BY A. G. WEBSTER.

ON THE DOUBLE REFRACTION OF DIELECTRICS IN A MAGNETIC FIELD IN A DIRECTION AT RIGHT ANGLES TO THE LINES OF FORCE. BY D. B. BRACE.

THE VISCOSITY OF LIQUIDS AT LOW RATES OF SHEAR. BY A. WILMER DUFF.

SOME PROPERTIES OF METALLIC FILMS DEPOSITED BY KATHODE DISCHARGES. BY J. G. COFFIN.

A COMPREHENSIVE BOYLES LAW APPARATUS. BY W. J. HUMPHREYS.

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A Lecture Room Method of Analyzing Irregular Electric Currents. By W. J. Humphreys.

The Excessive Nucleation of the Atmosphere Observed During the Recent Cold Weather. By Carl Barus.

Certain Data Bearing on the Occurrence of Lightning. By Carl Barus.

The Electrical Charges of Water Nuclei. By Carl Barus.

The Critical Current Density and Drop of Potential at the Cathode in Vacuum Tubes. By C. A. Skinner.

Screens Transparent only to Ultra Violet Light and their use in Spectrum Photography. By R. W. Wood.

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ADDRESS

BY

HENRY A. WEBER,

VICE-PRESIDENT AND CHAIRMAN OF SECTION C FOR 1902.

INCOMPLETE OBSERVATIONS.

In scientific literature many observations are recorded which, from the experimental proof offered, have been generally recognized as true, but which may be classed as *incomplete*, owing to the fact that the methods of investigation employed destroyed conditions that were later found to exist, or that subsequent discoveries modified the conclusions reached at the time of the original investigation.

As an illustration of this proposition the theories of alcoholic fermentation may be cited. The members of Section C will readily recall the long and bitter controversy which was waged between the two great masters, Liebig and Pasteur, and their respective adherents as to the true cause of this phenomenon.

It is interesting at this time, in the light of recent observations, to compare the two opposing theories.

According to Liebig alcoholic fermentation is caused by the decomposition of complicated nitrogenous bodies designated by him as putrescible material, and the molecular disturbance thereby produced is imparted to the fermenticible substance, sugar, and breaks it up into simpler bodies, alcohol and carbon dioxide.

The vitalistic theory, revived by Pasteur and brought to general recognition by his masterly and convincing experiments, teaches that alcoholic fermentation takes place only in the presence of a living micro-organism known as the

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yeast plant, and that the phenomenon of fermentation is intimately connected with the life process of this organism. The most convincing proof in support of the vitalistic theory was furnished by Pasteur in his methods of preventing fermentation and allied phenomena by simply heating perishable bodies to a temperature high enough to kill the living germs. In the case of acetic acid fermentation he showed that a temperature of 60° was sufficient to destroy the vinegar plant. At this temperature, he argued, the nitrogenous bodies, which Liebig claimed as the actual ferments, would remain intact. In spite of this, however, he showed that further fermentation was completely arrested so long as living germs were excluded.

Although the work of Pasteur was of the greatest importance to science and humanity, and his experimental evidence for the establishment of the vitalistic theory of fermentation was of the highest order, yet to the minds of many it was never entirely clear that the rival theory was completely overthrown. For a long time, however, the vitalistic theory had clear sailing. But the observations which led to its adoption remained incomplete until a few years ago Buchner startled the scientific world by the announcement that he had produced alcoholic fermentation without the presence of a single living germ. By simply mixing the extract, obtained by strong pressure from brewer's yeast, containing nothing but *dead* organic matter, he caused a solution of grape sugar to ferment, and, in fact, much more rapidly than if the yeast itself had been employed. Not only this—Buchner showed, furthermore, that the activity of this extract was completely destroyed at a temperature below that required to kill the yeast plant. This is the important point in Buchner's observations, because it was the failure to recognize this fact by Pasteur and his adherents that helped, more than anything else, to give the death blow to Liebig's theory. It is true that Liebig at first did not regard his putrescible matter or ferments as a product of the ever-present organisms, and it is also true that in Buchner's extract it is the enzyme of the yeast plant which produces

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the molecular disturbance that causes the grape sugar to break up into alcohol and carbon dioxide; yet it is gratifying to all those who were students of the great master to learn that, in the main, his attitude toward the process of fermentation has been finally vindicated.

It was the desire of the writer to discuss on this occasion some subject related to that branch of chemistry with which he is at present identified, and for this purpose the investigations in regard to assimilation of free nitrogen by plants were selected for consideration, since this question belongs in the category of "incomplete observations."

The importance to agriculture of knowing whether plants were capable of assimilating the free nitrogen of the air was impressed upon the minds of the early investigators of the subject of plant nutrition, because if this element in the free state so liberally supplied by nature should be found to be available as plant food, then it would fall into the same class with carbon, hydrogen and oxygen, which furnish the bulk of all vegetable matter, and about whose source the farmer need have no concern. In the early fifties the French chemist, Boussingault, conducted his memorable experiments with various kinds of plants in order to settle this question. His apparatus consisted of a large glass one-necked globe, into which he introduced a sufficient quantity of soil freed from nitrogen compounds by ignition. In this soil he planted a certain number of seeds, supplied a sufficient amount of water, and then hermetically sealed into the neck of the globe a smaller one filled with carbon dioxide. Under this arrangement the seeds were allowed to germinate and the plants to grow. After a period of several weeks the plants with their roots were carefully removed, dried, weighed and the nitrogen determined. He then determined the nitrogen in a like number of seeds themselves and compared the results. Out of fourteen experiments with various kinds of plants, including the legumes, he found in eleven cases a minus quantity of nitrogen in the plants and in the other three a small plus quantity. The latter results, however, he considered within the limits of errors of observation. His conclusion, therefore, was that the free nitrogen was not available plant food.

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At the same time another French chemist, Ville, investigated this problem. His experiments were made on a somewhat larger scale, his apparatus consisting of iron sash filled with glass. Ville uniformly found a marked increase in the content of nitrogen of the plants over that of the seeds, and since nitrogen compounds had been excluded during the time of his experiments, he concluded that the source of this increase was necessarily the free nitrogen of the air. His objection to Boussingault's conclusions was based upon the claim that, in the confined space in which the plants were forced to grow, their natural development was hindered.

Ville's criticism led Boussingault to repeat his experiments. In order to meet the former's objection to the limited amount of air in which the plants were forced to vegetate, he substituted a three-necked globe for the one employed before. By using an aspirator the air in this globe could be continually renewed, after passing it through a series of Wolf's bottles with the proper solutions to free it from nitrogen compounds. The results of this second series of experiments fully corroborated his former conclusions.

A committee appointed by the French Academy of Sciences to investigate the methods employed by Boussingault and Ville held that, in the latter's experiments, the introduction of nitrogen compounds was not excluded, and, therefore, pronounced in favor of Boussingault. If any doubt had remained in regard to the correctness of Boussingault's conclusions it was dispelled a few years later by the labors of Laws, Gilbert and Pugh. These investigators repeated the experiments of Boussingault with expensive and improved apparatus. Their work was performed with the greatest care and nicety, and their results fully vindicated Boussingault in the position he had taken.

The experimental evidence thus produced in favor of the proposition that the free nitrogen of the air was not available for vegetable growth was so clear and convincing that it was readily accepted by all, with the exception of one man. This man was George Ville, of France.

During all the time in which this opinion prevailed, he

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alone remained firm in the belief that his observations were true, and that plants could assimilate free nitrogen.

That plants can not assimilate free nitrogen directly was established by those early investigators without a doubt. On the other hand, it is now equally well established that free nitrogen does become available as plant food and plays an important part in vegetable production.

Evidently, therefore, the early investigations must have been incomplete, and at this distant day it is not difficult to point out wherein they were defective. Boussingault and Ville, as well as Laws, Gilbert and Pugh, regarded the soil as a mixture of mineral matter and humus. They had no conception of the fact that it was the home of a world of living micro-organisms, which in a variety of ways are silently and incessantly active in the transformation of matter essential to vegetable growth. Hence it is but natural that, in preparation of soil free from nitrogen compounds of all kinds, they should, what any chemist under like conditions would do, subject their soil to an intense heat.

Notwithstanding the prominence of these investigators and the general recognition accorded to their conclusions, further work in this connection was at most only retarded, but not entirely abandoned. Facts known at that time, and new observations gradually made in studying the soil in all of its phases, began to point in the opposite direction.

With the discovery of Berthelot, that the fixation of free nitrogen took place through the instrumentality of silent electrical discharges in the soil, were associated the manifold effects upon matter, shown to be due to the action of bacterial life. These latter discoveries may be divided into two groups:

1. Those showing the independent action of bacteria in the soil in causing fermentation, nitrification, denitrification and fixation of free nitrogen.

2. Those showing the fixation of free nitrogen by microbes in symbiotic relation to higher plants.

The first group of observations including the fixation of free nitrogen in the soil as pointed out by Berthelot and

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others is of great importance to agriculture, but the amount of available nitrogenous plant food produced by the various processes discovered is not sufficient for the demands of intensive farming. The truth of this statement can be inferred from the fact that, in addition to the enormous amount of nitrogenous material obtained from domestic and industrial sources, as well as from the extensive deposits of guano, there are, at the present time, about one million tons of Chili saltpeter employed annually by farmers the world over to maintain partially the fertility of their fields.

The second group of observations are of greater interest to agriculture, since they point out the way of securing from the free nitrogen of the air an ample amount of combined nitrogen to meet all the requirements of intensive farming. They make the farmer independent of the natural deposits of nitrogenous fertilizers, and furnish him the means of preventing his helplessness, in case these sources of plant food should become exhausted or otherwise unavailable.

From the time of the ancients down to the present day the legumes, especially the clovers, have occupied a unique position among agricultural crops. The beneficial effects of a crop of clover upon subsequent grain crops was a matter of practical experience in ancient and mediæval times, and this empirical knowledge was applied more or less in the practice of agriculture during those periods, as well as in modern times. When the science of chemistry began to shed light upon the production of vegetable matter, and showed the relation which plants, soil and air bore to each other, and especially that certain elements contained in the soil and air were essential to vegetable growth, the peculiar properties of the legumes received early attention. It was soon learned that the leguminous plants were pre-eminently nitrogen gatherers. Having accepted the conclusions of Boussingault in regard to free nitrogen as true, the teachers of agricultural chemistry were forced to explain this property of the leguminous plants in various ways. Besides the empirical observations, already alluded to, many comparative experiments were made which showed the beneficial effects

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of legumes on subsequent grain crops. As an example the experiment of von Wulffen may be cited. One-half of a certain field was allowed to remain in bare fallow, while the other half was sown to yellow lupines. After the lupines had fully developed the whole field was plowed and sown to rye. The yield of the two halves was determined separately with the following results:

	Grain.	*Straw.*
After lupines	532.5 lb.	1,072 lb.
After bare fallow	322 lb.	656.5 lb.

Here was a total increase in grain and straw of 626 pounds on that half of the field which had been sown to lupines, while nothing from without had been added to it except sixty pounds of lupine seed. The results of this experiment also show, what was claimed above, that the independent, bacterial activity of the bare fallow fell far short of producing sufficient available plant food for a full crop of rye.

In seeking an explanation for this effect of the legumes, Boussingault determined the amount of refuse, *i. e.*, stubble and roots, left in the soil by various crops. For this purpose he had the roots, etc., collected from measured plots of fields from which the crops had been harvested. His results are given in kilos per hectare and refer to dry matter. The nitrogen of the refuse was also determined. His figures are given in the following table:

	Crop.	*Refuse.*	*Nitrogen of Refuse.*
Wheat	1,002	518	2.1
Oats	1,608	650	2.6
Clover	1,975	1,547	27.9

If it be considered that the essential ash ingredients of plant food are equally high in the clover refuse, it will be seen that the manurial value of the clover refuse is out of all proportion to that of the two cereals, and consequently that clover must be a better forerunner for a grain crop than a grain crop itself. But Boussingault did not stop here. He also collected the refuse matter, roots and leaves from a crop of mangolds, and found that not only the dry matter,

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but also the nitrogen contained therein, was in excess of that of the clover. Here was a dilemma; for it was well known that, compared to legumes, root crops were poor forerunners for grain crops. The explanation for this apparent contradiction was found in extensive experiments made at Rothamstead. Laws and Gilbert raised root crops on the same field for years in succession without the application of manures, and found that they rapidly exhausted the surface soil. On the other hand, they showed that with clover, even after the removal of a highly nitrogenous crop, the soil was left richer in nitrogen than it was before. It is but fair to state in this connection that other investigators found much larger yields with clover than Boussingault. Thus, to take the other extreme, Heiden obtained from measured plots of clover, after it had become fully ripe, and by removing the whole aerial portion of the crop, the following results, expressed in kilos per hectare:

	Roots.
Dry matter	8,469.6
Nitrogen	275.3

Laws and Gilbert, Heiden, [illegible] fact all who investigated this subject explained this large accumulation of nitrogen principally by the assumption that clover, on account of its deep roots, had the power, in a marked degree, of obtaining a large portion of its food from the subsoil and bringing it to the surface. Furthermore, it was assumed that on account of the great leaf surface of clover, its more succulent nature and its longer period of growth, it was capable of collecting more ammonia from the air than was the case with grasses and cereals. Another peculiarity which the legumes were thought to possess was their ability to assimilate, in a higher degree than other crops, the reserve nitrogen of the soil. This assumption would explain, of course, why these plants should make a luxuriant growth on soils on which, for lack of available nitrogen, other crops failed to make a good stand, but it would not throw any light upon the fact, established by general observation, that the total fixed nitrogen of the soil was so materially increased.

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It may be truthfully said that all these explanations taken together were not entirely satisfactory to those who were engaged in the teaching of agricultural chemistry, but, in short, this was the status of the nitrogen question for a generation or more, when Hellriegel announced before the section of agricultural chemists of the German Association of Men of Science and Physicians, at their meeting in 1886, that the leguminous plants could assimilate the free nitrogen of the air, and that this assimilation was intimately connected with the nodules appearing upon the roots of these plants. The hearty applause with which this announcement was received at the meeting, and the widespread and spontaneous interest which it awakened all over the world, showed that it came as a relief to agricultural chemists and vegetable physiologists in general. The report of Hellriegel was based upon observations and experiments made during the four preceding years. He had been appointed jointly with Wilfarth a[illegible] of nitrogen assimilation by plants. The [illegible] made in pots containing four kilos of [illegible]d sand, to which the proper amount of mineral plant [illegible] free from combined nitrogen, had been added. The main points established were as follows:

1. When no combined nitrogen was added to the artificial soil the acquisition of nitrogen over that contained in the seeds was naught. This was true for all kinds of plants, including the legumes.

2. The development of all kinds of plants and the acquisition of nitrogen were in direct proportion to the amount of combined nitrogen added.

3. When a small quantity of natural soil, or of an aqueous infusion of such soil, was added to the contents of the pots, and no other combined nitrogen introduced, the graminaceous plants, as well as some other families of plants, died of nitrogen starvation, and their acquisition of nitrogen was naught.

4. Under the same conditions the leguminous plants, after a period of nitrogen starvation, began to recuperate, the

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foliage returned to its normal green color, and the plants continued to grow, in some cases vigorously, to complete maturity, and acquired all the nitrogen necessary for this development.

5. The graminaceous plants are dependent upon the combined nitrogen of the soil for their development.

6. The legumes are independent of the combined nitrogen of the soil and can acquire all the nitrogen for their complete development from the air, and, furthermore, not from the small quantity of combined nitrogen contained in the air, but from the *free* nitrogen.

7. Whenever, under these conditions, the legumes acquired nitrogen, this acquisition was invariably accompanied with the appearance of tubercles on their roots.

8. Sterilization of the natural soil or of the soil infusion destroys its effect.

A year later, 1887, Wilfarth made a further report on this subject. In one experiment made by Hellriegel and Wilfarth the classical method of Boussingault was employed. They placed into a large glass globe four kilos of ignited sand, mixed with sufficient water and the necessary mineral constituents of plant food free from nitrogen compounds. They also added a small quantity, an aqueous infusion, of a soil in which peas had been previously grown. In the artificial soil thus prepared they planted a pea, a grain of oats and a buckwheat seed. The globe was hermetically sealed with a ground glass stopper and the necessary carbon dioxide for the growth of the plants was introduced from time to time. The oat and buckwheat plants grew only till the seeds had become exhausted, and acquired no nitrogen in excess of that contained in the seeds. On the other hand, the pea plant made a vigorous and normal growth and was still growing when the report was made. A large part of this plant had been removed and was found to contain 6.55 grams of dry matter and 0.137 gram of nitrogen.

This interesting experiment not only corroborates the claims of these investigators, but it completes the original experiment of Boussingault, in that it restores the condition

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of natural soils, which he had destroyed by his method of removing fixed nitrogen. In this connection it is of interest to refer again to the position on the nitrogen question occupied alone by Ville. It can readily be understood that, in the large apparatus employed by this investigator, the chances for complete sterilization were very remote, especially since no particular attention was paid to this point. Microbes from the soil could easily have found their way into his large case through dust or otherwise, and in the presence of organic matter arising from the seeds and the roots of the plants, could, in a short time, become active in fixing the free nitrogen of the air. The contention of Ville that, in his experiments, free nitrogen of the air was assimilated by plants may, therefore, have been sound.

But to return to the line of thought broken by this digression, Wilfarth reported some important gains in nitrogen by lupines grown in pots with four kilos of nitrogen-free sand on addition of a measured quantity of soil infusion containing not more than seven-tenths of a milligram of fixed nitrogen. The yields are as follows:

WITH SOIL INFUSION:

No. 3. 44.73 grms. dry matter with 1.099 grms. nitrogen.
No. 4. 45.62 grms. dry matter with 1.156 grms. nitrogen.
No. 5. 44.48 grms. dry matter with 1.194 grms. nitrogen.
No. 6. 42.45 grms. dry matter with 1.337 grms. nitrogen.

WITHOUT SOIL INFUSION:

No. 9. 0.918 grms. dry matter with 0.0146 grms. nitrogen.
No. 10. 0.800 grms. dry matter with 0.0136 grms. nitrogen.
No. 11. 0.921 grms. dry matter with 0.0132 grms. nitrogen.
No. 12. 1.021 grms. dry matter with 0.0133 grms. nitrogen.

By the sole employment of a small quantity of soil infusion containing an infinitesimal amount of combined nitrogen, in pots holding about eight pounds of sand, the plants made an average gain in dry matter of 42.9 grams, and in nitrogen of 1.18 grams over the same kind of plants grown under the same conditions without this addition. This remarkable

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result was surely worthy of the general interest which its publication evoked.

Numerous experimenters all over the world at once began to pay attention to the little tubercles, and they were investigated from all points of view. Their morphology was studied by Frank, Laurent and others. For this purpose Frank, as well as Laurent, grew plants partly in water culture with the production of root tubercles. Since their labors belong to the domain of biology this simple reference to them here will suffice.

The results of all investigations from a chemical standpoint verified the conclusions reached by Hellriegel and Wilfarth. But, in addition to this, a great many new facts bearing upon this subject were obtained. Bréal analyzed the nodules of various legumes and found that the content of nitrogen in the dry matter varied from three to seven per cent., and was higher than that of any other part of the plants excepting the seeds. This fact is significant.

Bréal also obtained results similar to those of Hellriegel and Wilfarth by germinating peas between moistened filter papers, inoculating the roots, after they had attained the length of a few centimeters, with a needle which had been plunged into a tubercle, and then growing the plants in nitrogen-free sand containing the necessary mineral ingredients of plant food.

This investigator also grew peas in water culture. After germinating seeds between moistened filter papers as before, and after the roots had attained a length of three or four centimeters he inoculated them with a needle which had been inserted into a tubercle of alfalfa, and placed two of the young plants in a culture jar, which contained a nutrient solution free from combined nitrogen. The peas grew regularly so long as they found nourishment in the cotyledons. Then a period of nitrogen starvation set in, after which the plants recuperated and grew to maturity with the production of fruit. The period of vegetation extended from April 2 to June 10. At the latter date the roots contained numerous tubercles. The stalks and roots were separated, dried at

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110° C. and weighed. The nitrogen of both portions was determined, as was also the weight and nitrogen of two seeds similar to those used in the culture experiments. The following table gives the results:

	Dry Matter, Grams.	Nitrogen, Per cent.	Nitrogen, Total.
Stalks	3.785	2.35	0.089
Roots	1.165	2.60	0.030
Total	4.95	—	0.119
Seeds	0.502	3.60	0.018
Gain	4.448	—	0.101

The table shows that the plants contained ten times as much organic matter and six and six-tenths times as much nitrogen as the seeds from which they were derived; also that the percentage of nitrogen of the roots was greater than that of the aerial portion. Now when it is considered that, in this experiment, there was no nitrogen compound of any kind present, except the infinitesimal quantity introduced by puncturing the roots with the needle, and that in two small plants there was a gain of 101 milligrams of combined nitrogen, the claim for the assimilation of free nitrogen must be regarded as established.

The order of leguminous plants, therefore, occupies a unique position in the art of agriculture. The experimental evidence herein submitted shows conclusively why leguminous crops have for ages been recognized as being of special value in maintaining soil fertility, and the discussion of this subject points to the fact that, in many walks and practices of life, empiricism has been in advance of science.

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PAPERS READ.

[The following papers were read before the American Chemical Society and Section C, in joint session.]

THE COMPOSITION OF FRESH AND CANNED PINEAPPLES. BY L. S. MUNSON AND L. M. TOLMAN.

CHEMICAL COMPOSITION OF SOME TROPICAL FRUITS AND FRUIT PRODUCTS. BY E. M. CHACE, L. S. MUNSON AND L. M. TOLMAN.

NATURE OF THE WORK OF THE BUREAU OF CHEMISTRY, DEPARTMENT OF AGRICULTURE. BY H. W. WILEY.

THE COMPOSITION OF RENOVATED OR PROCESS BUTTER. BY C. A. CRAMPTON.

THE COMPOSITION OF SPIRITS PRODUCED FROM GRAIN, AND THE CHANGES UNDERGONE BY THE SAME WHEN STORED IN WOODEN PACKAGES. BY C. A. CRAMPTON.

IODINE ABSORPTION OF OILS; COMPARISON OF METHODS. BY L. M. TOLMAN AND L. S. MUNSON.

THE RELATION OF THE SPECIFIC GRAVITY OF URINE TO THE SOLIDS PRESENT. BY JOHN H. LONG.

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Derivatives of Isoapiol and Isosafrol. By F. J. Pond.

Some Double Salts of Organic Acids. By Jas. Lewis Howe.

Report of the Committee on Atomic Weights. By F. W. Clarke.

Report of the International Committee on Atomic Weights. By F. W. Clarke.

On the Need of Systematic Action Regarding the Question of Substitution and Adulteration. By Leon L. Watters.

The Chemical Work of the Bureau of Soils, Department of Agriculture. By Frank K. Cameron.

The Action of Metallic Magnesium on Aqueous Solutions By Louis Kahlenberg.

Action upon Metals of Solutions of Hydrochloric Acid in Various Solvents. By Harrison E. Patten.

A Proposed Method of Examining Wood Treated to Resist Fire. By C. F. McKenna.

An Electric Test Retort. By C. F. McKenna.

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THE BASIC SULPHATES OF BERYLLIUM. BY CHARLES LATHROP PARSONS.

THE PICRATES OF THE RARE EARTHS. BY L. M. DENNIS AND W. C. GEER.

THE CHEMICAL WORK OF THE U. S. GEOLOGICAL SURVEY. BY F. W. CLARKE.

A METHOD FOR THE COLORIMETRIC DETERMINATION OF PHOSPHATES AND SILICATES WHEN BOTH ARE PRESENT. BY OSWALD SCHREINER.

A NEW (?) METEORITE FROM AUGUSTA COUNTY, VIRGINIA. BY H. D. CAMPBELL AND JAS. LEWIS HOWE.

PREPARATION OF STANDARD SOLUTIONS OF SULPHURIC ACID BY DIRECT DILUTION. BY ARTHUR JOHN HOPKINS.

A VOLUMETRIC METHOD FOR THE DETERMINATION OF CHROMIC ACID IN CHROME PIGMENTS. BY E. E. EWELL.

SUGGESTED IMPROVEMENT IN CHLORINE DETERMINATION. BY CHAS. BASKERVILLE.

THE DETERMINATION OF THE HYDRO-CARBONS IN ILLUMINATING GAS. BY L. M. DENNIS AND J. G. O'NEILL.

REDUCTION WITH SOLUBLE ANODES. BY WILDER D. BANCROFT.

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Solubility Curves for Magnesium Carbonate in Aqueous Solutions of Sodium Chloride, Sodium Sulphate and Sodium Carbonate. By Frank K. Cameron and Atherton Seidell.

The Optical Rotating Power of Camphor Dissolved in Inorganic Solvents: Phosphorus Trichloride, Sulphur Dioxide, Sulphur Monochloride. By Herman Schlundt.

Report of Committee on Atomic Weight of Thorium. By Chas. Baskerville.

New Syntheses in the Phenmiazine Group. By Marston Taylor Bogert.

Some Picryl Derivatives of Phenols. By H. W. Hillyer.

The Action of Unsymmetrical Hydrazines on the Chlorine Derivatives of the Quinones of the Benzene Series. By Wm. McPherson, W. L. Dubois and C. P. Linnville.

A Convenient Form of Table for Calculations of Chemical Weights. By F. P. Dunnington.

Corrosion of Some Ancient Coins. By F. P. Dunnington.

Some New Phenomena Exhibited by Soap Solutions. By H. W. Hillyer.

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CONDENSATION OF TRIPHENYLMETHYL TO HEXAPHENYLETHANE. BY M. GOMBERG.

METHODS FOR THE EXAMINATION OF BITUMENS AND THEIR DETERMINATION AND SEPARATION. BY CLIFFORD RICHARDSON.

PORTLAND CEMENT, CONSIDERED AS A SOLID SOLUTION. BY CLIFFORD RICHARDSON.

A CHARACTERIZATION, CLASSIFICATION AND NOMENCLATURE OF NATIVE BITUMENS. BY CLIFFORD RICHARDSON.

SOME OF THE WORK OF THE BIO-CHEMIC DIVISION, DEPARTMENT OF AGRICULTURE. BY E. A. DE SCHWEINITZ.

DOES CHOLESTEROL OCCUR IN CORN OIL? BY A. H. GILL.

MILEY'S COLOR PHOTOGRAPHY. BY W. G. BROWN.

NOMENCLATURE OF ELEMENTS AND RADICALS. BY W. G BROWN.

HYDROCHLORIC ACID AS AN ELECTROLYTIC SOLVENT. BY E. C. FRANKLIN.

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ADDRESS

BY

JOHN JOSEPH FLATHER,

VICE-PRESIDENT AND CHAIRMAN OF SECTION D FOR 1902.

MODERN TENDENCIES IN THE UTILIZATION OF POWER.

It has been stated that to the construction and perfection of her machinery, more than to any other cause, may be ascribed the present commercial supremacy of the United States.

Be that as it may, the economical production of her manufactures and the convenient adaptations of time and labor-saving devices in all the various lines of constructional work have certainly exerted a wonderful influence in the upbuilding of her industries.

Specialization in the manufacture of machine tools and labor-saving devices has followed closely the segregation of processes in other lines of industry, and thus there has been created a multitude of special machines, each designed to perform some single and often very simple operation.

Among other significant features the present tendency in the development and use of this class of machinery is marked by the adaptation of compressed air and the application of electric power to machine driving. In the use of compressed air, the facility of adaptation to various requirements which are in many cases additional to the supply of motive power, is a valuable feature peculiar to this system and one which is susceptible of extension along many lines.

The labor cost in most machine shops and other works is so much greater than the cost of power that any expedient by which the labor cost may be appreciably reduced is justified,

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even though the efficiency of the agent itself be low. Whenever new methods or agencies cause an increased production with a given outlay for labor, we shall find these methods superseding the old, even though the cost of the power required be greater than before. The saving of power is a consideration secondary to the advantages and economical output obtained by its use.

While economy in the use of power should therefore be secondary to increased output, yet careful attention to details will often greatly reduce the useless waste of power.

Engineers have recognized for some time past that there is a very great percentage of loss due to shaft friction, which, in railroad and other shops where the buildings are more or less scattered, may be as great as 75 per cent. of the total power used. In two cases known to the speaker these losses are 80 and 93 per cent., respectively. In the ordinary machine shop this loss will probably average from 40 to 50 per cent. No matter how well a long line of shafting may have been erected, it soon loses its alignment and the power necessary to rotate it is increased.

In machine shops with a line of main shafting running down the center of a room, connected by short belts with innumerable counter-shafts on either side, often by more than one belt and, as frequently happens, also connected to one or more auxiliary shafts which drive other counter-shafts, we can see why the power required to drive this shafting should be so large. There is no doubt, however, that a large percentage of the power now spent in overcoming the friction of shafting in ordinary practice could be made available for useful work if much of the present cumbrous lines of shafting were removed.

Manufacturers are realizing the loss of power which ensues from the present system of transmission, and we find a general tendency to introduce different methods by which a part of this loss will be obviated. Among these are the introduction of hollow and lighter shafting, higher speeds and lighter pulleys, roller bearings in shaft hangers, and the total or partial elimination of the shafting.

Independent motors are often employed to drive sections

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of shafting and isolated machines, and among these we find steam and gas-engines, electric motors, compressed air and hydraulic motors, although the latter have not been used for this purpose to any appreciable extent.

In the choice of motors, until quite recently the steam-engine has heretofore been used, especially where the units are relatively large. An interesting example of this is noted in the sugar refinery of Claus Spreckels, in Philadelphia, in which there are some 90 Westinghouse engines about the works, many of them being of 75 and 100 horse-power each; others of 5 and 10 horse-power only. A similar subdivided power plant involving 42 engines was erected several years ago at the print works of the Dunnell Co., Pawtucket, R. I.

It was only a comparatively few years ago when several large and economical Corliss engines were replaced at the Baldwin Locomotive Works by a greater number of small, simple expansion engines, which actually required about 15 per cent. more steam per horse-power hour than the Corliss engines. This loss, however, was only apparent, for by increasing the number of units and locating them at convenient centers of distribution much of the shafting and belting could be dispensed with and an actual saving was obtained. Later, these simple engines were replaced by a number of compounds, some eighteen being in service; subsequent tests on these showed a saving of 36 per cent. over that obtained by the use of the simple engines.

More recently, however, the electric motor has superseded the steam-engine for this work, as its economy and convenience over the latter are now thoroughly recognized.

The statistics of American manufacturing, compiled by Mr. T. C. Martin for the United States Census Office, show that at the time of the last census, in 1900, electric power was less than five per cent. of all that was in use in such plants, or about 500,000 horse-power out of a total of 11,000,000; but, as Mr. Martin states, things are to be judged by tendencies rather than by the *status quo*, and these electric motor figures exhibit an increase of 1,900 per cent. during the decade.

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The introduction of the electric motor in machine shops and factories was at first looked upon with disfavor and was opposed by many manufacturers, but the innovation obtained a foothold, and advantages which were at first unforeseen were found to attend its use, so that now it is being very generally adopted for a wide variety of work.

A considerable difference of opinion exists as to whether individual motors should be used with each machine, or whether a number of machines should be arranged in a group and driven from a short line shaft.

There are well-defined conditions to which each system is best adapted, but there are wide limits between which there appears to be no general rule, and we find both methods occupying the same field.

For isolated machines and for heavy machines that may be in occasional use the individual motor is particularly well adapted, as it consumes power only when in operation. It is, however, necessary that each motor thus connected shall be capable of supplying sufficient power to operate its machine under the heaviest as well as lightest loads. In certain cases, moreover, the load is liable to very great irregularity, as for instance in metal-working planers, in which the resistance offered by the machine at the moment of reversal of the platen is far higher than at other times, and may be so great as to endanger the armature of the motor. Under these conditions it is necessary to use a motor of much larger capacity than the average load would indicate.

Fortunately with electric motors the rated capacity is usually less than the safe maximum load, which is determined either by the heating of the conductors, tending to break down the insulation, or by excessive sparking at the brushes. For momentary overloads relatively large currents may pass through the coils without injury to the insulation, since the temperature effect is cumulative and requires time for its operation. However, for continuous periods of considerable length it is usually unsafe to operate the motor much above its rated output.

Ordinarily in machine driving the motor is shunt-wound,

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and the current through the field coils is constant under all conditions of load; but to obtain the best results with that class of machinery in which the load is intermittent and subject to sudden variations, the motor should be compound-wound so as to increase the torque without an excessive increase of current in the armature.

In many cases with individual motors, owing to wide variations in power required, the average efficiency of the motor may be very low; for this reason a careful consideration of the conditions governing each case indicates that for ordinary machine-driving, especially with small machines, short lengths of light shafting may be frequently employed to good advantage, and the various machines, arranged in groups, may be driven from one motor. By this method fewer motors are required, and each may be so proportioned to the average load that it may run most of the time at its maximum efficiency.

When short lengths of shafting are employed the alignment of any section is very little affected by local settling of beams or columns, and since a relatively small amount of power is transmitted by each section, the shaft may be reduced in size, thus decreasing the friction loss. Moreover, with this arrangement, as also with the independent motor, the machinery may often be placed to better advantage in order to suit a given process of manufacture; shafts may be placed at any angle without the usual complicated and often unsatisfactory devices, and a setting-up room may be provided in any suitable location as required, without carrying long lines of shafting through space. This is an important consideration, for not only is the running expense reduced thereby but the clear head-room thus obtained, free from shafting, belts, ropes, pulleys, and other transmitting devices, can be more easily utilized for hoists and cranes, which have so largely come to be recognized as essential to economical manufacture.

In arranging such a system of power distribution the average power required to drive is of as much importance as the maximum, for in a properly arranged group system

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the motor capacity need not be the equivalent of the total maximum power required to operate the several machines in the group, but may be taken at some value less than the total, depending upon the number of the machines and the average period of operation. On the other hand, as already shown, the motor capacity of independently driven machines must not only equal the maximum power required to drive the machine at full load, but it must be capable of exerting a greatly increased momentary torque. In any case large units should be avoided, for the multiplication of machines driven from one motor entails additional shafting, counter-shafts and belting which may readily cause the transmission losses to be greater than those obtained with engines and shafting alone, besides frustrating some of the principal objects of this method of transmission.

As far as the efficiency of transmission is concerned, it is doubtful whether, in a large number of cases, motor-driving *per se* is any more efficient than well-arranged engines and shafting.

As already pointed out, the principal thing to be kept in mind is a desired increase in efficiency of the shop plant in turning out product, with a reduction in the time and labor items, without especial reference to the fuel items involved in the power production.

On account of the subdivision of power which results from the use of many motors, there is less liability of interruption to manufacture, and in case of overtime it is not necessary to operate the whole works, with its usual heavy load of transmitting machinery.

Another advantage is the adaptability to changes and extensions; new motors may always be added without affecting any already in operation, and the ease with which this system lends itself to varying the speed of different unit groups is a very potent factor in its favor.

One serious obstacle to the use of connected motors with machine tools is the difficulty of obtaining speed variation, which is so necessary with a large proportion of the machines in common use. A certain amount of variation can be

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obtained by rheostatic control—a wasteful method; or by using a single voltage system with shunt field regulation; but the variation in either case is very limited. This, however, may be increased by using a double commutator if space will permit.

The three-wire, 220-volt system, offers many advantages for both power and lighting systems, and is very frequently employed. Variations of speed may be obtained with this system by using a combination of field regulation with either voltage, and, in rarer cases, the use of a double commutator motor.

A method which has been used recently with considerable satisfaction involves the use of a three-wire generator, with collector rings connected to armature winding similar to that of a two-phase rotary converter. Balancing coils are used, and the middle points of these are connected to the third wire, which is thus maintained at a voltage half way between the outer wires. This system is simple and economical, and possesses all the advantages of the ordinary three-wire method; it permits similar variations in speed by field regulation with either voltage; and if still wider ranges are desired a double commutator motor may also be used.

In other recent installations the four-wire multiple voltage system is used, which permits of very wide variations of speed in the operation of the tool. This system gives excellent results and removes one of the objections urged against direct-connected motor-driven tools, namely, that such machines are not sufficiently flexible in regard to speed variation, and that such variation can only be obtained by throwing in resistances which cut down the efficiency of the motor, or by varying the strength of field which reduces the torque.

The multiple voltage system, however, has some serious disadvantages. It cannot usually be operated from an outside source of power without rotary transformers; the generating sets and switch-board are complicated, and the total cost of installation is expensive; yet with these drawbacks the system is growing in favor, as it has manifest advantages which outweigh the objections.

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The storage battery has been used to some extent to obtain multiple control and is suggestive of interesting possibilities, but in its present form it is not altogether desirable for machine tools.

In many of the larger sizes of certain metal-cutting machines it is probable that marked changes will be produced in the immediate future, and the indications are that direct-connected motors with wide variations of speed and power will be incorporated in the new designs.

The recent improvements in the manufacture of certain grades of tool steel have shown indisputably that the present designs of machine tools are not sufficiently heavy to stand up to the work in order to obtain the economy of operation which results from the use of such steels. Higher speeds, heavier cuts and greater feeds may be obtained if the machines will stand the strain, but in most cases the capacity of the machine is not commensurate with the ability of the tool to remove metal. With cutting speeds of 100 to 200 feet per minute, it is evident that the power requirements will be much greater than for the ordinary machines of to-day, which have a cutting speed of from 10 to 30 feet per minute. As an illustration of what can be done with these new tool steels the speaker was recently shown some steel locomotive driving-wheels which had been turned up in two hours and forty minutes, whereas the regular time formerly required was not less than eight hours. In this case even better results could have been obtained, but the belts would not carry the load.

Here then we find an interesting field for the direct-connected motor with ample power and speed variation for any work which it may be called upon to perform.

While the preference is easily given to continuous-current motors for the purposes of machine driving, yet we find alternating current motors used to a considerable extent, the proportion of motors in service being about one to five in favor of the continuous current motor. Both synchronous and induction motors are employed, but the advantages possessed by the latter cause this type to be preferred, although

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in long distance transmissions, both types should be used in order to obtain satisfactory regulation. As shown by Mr. H. S. Meyer,* the induction motor can readily be worked at variable speeds, which is accomplished in three different ways: (1) by rheostatic control, which is decidedly the cheapest and easiest method to manipulate; (2) by varying the impressed voltage, which, however, necessitates the use of a transformer or compensator with variable ratio; this is very inefficient at the lower speeds and can only be used under certain conditions; and (3), by altering the number of poles, which is mechanically very complicated, but where the speed variation is only one-half or one-quarter it may be used efficiently.

One serious disadvantage met with in all induction motors is the lag produced by self-induction, and its reaction on the circuit. This lag is particularly unsatisfactory with intermittent service, such as machine driving, where the motors have to run under light and variable loads; in such cases the power factor is probably not over 60 or 70 per cent.

Reference has been made to the use of compressed air and its facility of adaptation to various requirements, but it is evident from an inspection of some of the devices in use that enthusiasm for new methods, rather than good judgment, has controlled in many of its applications.

For some years compressed air was used only in mines, where it produced marked economies in underground work. Later, compressed air was introduced into manufacturing lines, and to-day its use in railroad and other machine shops, boiler shops, foundries and bridge works is being widely extended. In the Santa Fé railroad shops at Topeka there are over five miles of pipe in which compressed air is carried to the different machines and labor-saving appliances throughout the works.

In such shops air is used to operate riveting machines, punches, stay-bolt breakers, stay-bolt cutters, rotary tapping and drilling machines, flue rollers, rotary grinders, rotary saw for sawing car roofs, pneumatic hammers, chisels and caulking

* London *Engineering*. April 19, 1901.

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tools, flue welders, boring and valve-facing machines, rail saws, machine for revolving driving-wheels for setting valves, pneumatic painting and whitewashing machines, dusters for car seats and the operation of switching engines about the yard. It is also used in the foundry for pressing and ramming molds, and for cleaning castings by the sand blast; but its greatest field of usefulness is its application to hoisting and lifting operations in and about the works.

New applications of compressed air are constantly being made, and each new use suggests another. This has a tendency to increase the number of appliances which are intended to be labor-saving devices, but in many cases the work could be done just as well and much more cheaply by hand.

A case in point is seen in an apparatus which was at one time in use on one of our prominent western roads. It was a sort of portable crane hoist which could be fastened to the smoke-stack of a locomotive, whereby one man could lift off the steam chest casing. The hoisting apparatus weighed about twice as much as the steam chest and took three men to put it up. When piece work was adopted two men easily lifted off the steam chest and this "time and labor-saving device" was relegated to the scrap heap.

While compressed air has been used to some extent for inducing draft in forge fires, it is unquestionably a very expensive method. Tests to determine this show that it costs twenty-five times as much to produce blast in that way as it would with a fan.*

The success and economy which has attended the use of compressed air in so many lines of work has led to its adoption in fields which are much better covered by electrically operated machines. While compressed air has been used under certain conditions very satisfactorily to operate pumps and engines, printing presses, individual motors for lathes, planers, slotters, dynamos and other work, it does not follow that it is always an economical agent under these various uses, or that other methods could not be used even more satisfactorily in the majority of cases.

* Proc. Western Ry. Club, 1898.

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It has been proposed to use individual air motors in machine shops and do away with all line shafting, except possibly for some of the heavier machinery. This use of compressed air seems entirely outside the pale of its legitimate field; the general experience thus far indicates that rotary motors are not at all economical and generally are not as satisfactory as electric motors.

Exceptions are to be found in the small portable motors for drilling and similar operations, to which electricity is not at all adapted and where compressed air has been found to give excellent results. The saving obtained by the use of such portable drills as compared with a ratchet drill is very marked.

Although these tools are very successful they are still rotary motors, not exempt from some of the objectionable features which seem to be inseparable from them. It is not surprising, therefore, to find a tendency to employ reciprocating pistons and cranks in these portable machines, and we note such tools weighing only forty pounds capable of drilling up to two and a half inches diameter.

While the field is to some extent limited, yet the uses of compressed air are certainly not few, and in many lines of work marked economy results from its use.

In most cases no attempt has been made to use the air efficiently; its great convenience and the economy produced by its displacement of hand labor have, until recently, been accepted as sufficient, and greater economies have not been sought.

In the matter of compression we still occasionally find very inefficient pumps in use, but manufacturers generally have found that it pays to use high-grade economical compressors. The greatest loss is that in the air motor itself. In a large number of cases it is impracticable or, at most, inconvenient to employ reheaters, and we find very generally that the air is used at normal temperature for the various purposes to which it is applied.

To obtain the most satisfactory results the air must be used expansively, but usually where the demand for power

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is intermittent no attempt has been made to reheat the air, and as a result the combined efficiency of compressor and motor is quite low, varying in general from 20 to 50 per cent. While low working pressures are more efficient than high, the use of such pressures would demand larger and heavier motors and other apparatus which is undesirable.

The advantages of higher pressures in reducing cost of transmission are also well recognized, and the present tendency is to use air at 100 to 150 pounds instead of the 60 or 70 pounds of a few years ago.

By reheating the air to a temperatureo f about 300° F., which may often be accomplished at small expense, the efficiency is greatly increased; in some cases this has been shown to be as high as 80 per cent. While the lower pressures are yet more efficient, the loss due to higher compression is not serious.

If air be used without expansion it will be seen that there is a material loss in efficiency; but, on the other hand, if it be used expansively without reheating, trouble may be experienced, due to the drop in temperature below the freezing point. If moisture be present this will cause the formation of ice, which may clog the passages if proper precautions are not taken to prevent it. The low temperature will not in itself cause trouble; if, therefore, the moisture which the compressed air holds in suspension be allowed to settle in a receiving tank, placed near the motor or other air apparatus and frequently drained, less trouble will be experienced from this cause.

While it may be impracticable to reheat the air in certain cases, yet there are many situations where a study of means to overcome the losses referred to would result in marked economies.

The greater adaptability of compressed air to various purposes causes its use to increase along with that of the electric motor, for it has a different field of usefulness, independent of power transmission; at the same time, when the requirements are properly observed in its production and use, its economy as a motive power in special cases compares

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favorably with other systems. With a better knowledge of the principles involved we may expect much better results than have yet been attained.

But compressed air possesses so many advantages that, however inefficient it may be as a motive power, its application to shop processes will be continually extended as its usefulness becomes better known.

Mention has been made of the use of hydraulic motors as a factor in the subdivision of power, but these are being used to such a limited extent for this purpose that we shall not consider them at the present time.

There is, however, a growing field of usefulness for hydraulic power in manufacturing operations which is peculiar to this agent alone, namely, its use in forging and similar work. Where hydraulic power exists for this purpose it is also generally used for a variety of purposes which could be accomplished just as well, and often more economically, by steam or compressed air; but in forging operations where heavy pressures are required hydraulic power is infinitely better than either.

The compressibility of air is an objection in many lines of work, and it is now well recognized that the effect of a hammer blow is oftentimes merely local. As Mr. H. F. J. Porter has so ably shown elsewhere,* the pressure applied in forging a body of iron or steel should be sufficient in amount and of such a character as to penetrate to the center and cause flowing throughout the mass; as this flowing of the metal requires a certain amount of time the pressure should be maintained for a corresponding period.

Hydraulic pressure, instead of a hammer, should, therefore, be used to work it into shape. Under its action the forging is slowly acted upon and the pressure is distributed evenly throughout the mass, whereas under the high velocity of impact of the hammer the metal does not have time to flow, and thus internal strains are set up in the mass, which may cause serious results, especially with certain steels which have not the property of welding.

* Trans. A. S. M. E., Vol. XVII.

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Besides the fundamental defects incident to the method, it is very troublesome to use a hammer in certain lines of work, on account of mechanical difficulties of manipulation.

The quality of the steel is very much improved by the processes of hydraulic forging, and we find a marked tendency to substitute this method in a wide variety of work in which presses are employed varying in capacity from 20 tons to 14,000 tons.

We are all familiar with the fact that the magnificent 125-ton hammer made by the Bethlehem Steel Co. lies idle, while the work for which it was intended is done by a 14,000-ton hydraulic press operated by an engine of 15,000 horse-power; it may not be so generally known, however, that all forgings except small pieces are done on hydraulic presses, and that the largest hammer in actual operation is one of 6 tons capacity in the blacksmith shop.

The pressure used in these works is 7,000 pounds per square inch, but the present tendency indicates the use of a so-called low-pressure transmission service under a pressure of 400 or 500 pounds, with an intensifier at the press which raises the pressure to 2,500, 5,000, 7,000 pounds, or whatever may be required.

In this case the lifting and lowering of the ram of the press is effected by low-pressure water, so that the cylinder always remains filled, and the high pressure is only brought to bear the moment the dies come in contact with the pieces to be forged. The intensifier is built in multiple, which permits of a variable force to suit the work to be done; its action and control are extremely simple, and results are produced which show a marked increase in speed and a decided economy in operation. Some of the recent German hydraulic forging machines equipped with intensifier operate at a speed of forty to seventy strokes per minute on finishing, and twenty to thirty strokes per minute for the heaviest work.

The success which has attended the use of hydraulic power in forging is causing it to be applied to other and similar work to an increasing extent. In boiler works, railroad and

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locomotive shops, bridge works and shipyards it is used along with compressed air, but where heavy pressures are desired hydraulic power is greatly to be preferred; hence we find it operating machines for punching and shearing heavy plates and sectional beams, riveting machines, stationary and portable, flanging and bending machines, tube upsetting machines, wheel and crank-pin presses, lifting jacks and hoists of all kinds.

For heavy boiler work hydraulic riveting seems especially well adapted, as an intensity of pressure can be brought to bear upon the plates which is obtained by no other method.

We have already stated that compressed air as now used without reheating is not at all efficient as a source of motive power, since the combined efficiency of compressor and motor, even under favorable conditions, is not more than 50 per cent. of the available energy put into the compressor. In other cases the efficiency is as low as 20 per cent.

In the transmission of air, within reasonable limits, the loss in transmission if the pipes be tight need not be considered, for although there is a slight loss in pressure due to the frictional resistances of the pipes, yet there is a corresponding increase in volume due to drop in pressure, so that the loss is practically inappreciable.

There should be no comparison between the cost of power by compressed air and its brilliant rival, electricity, since each has its own field of usefulness, yet it may be interesting to note for our present purposes the efficiency of electric power. A modern shop generator belted from an engine will have an efficiency of about 90 per cent. when working under favorable conditions, but as the average load is ordinarily not more than two-thirds full load, and often much less, the efficiency will not usually be more than 85 per cent. Since the engine friction was added to the losses in compression, so also it should be considered here, in which case the efficiency of generation will lie between 75 and 80 per cent. With a three-wire 220-volt system, which is very suitable for ordinary shop transmission when both light and power are to be taken off the same dynamo, the loss in transmission need not be

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more than 5 per cent., so that the efficiency at the motor terminals will not be far from 75 per cent. With motors running under nearly constant full load the efficiency of motor may be 90 per cent.; but with fluctuating loads this may fall to 60 per cent. at quarter load. In numerous tests made by the speaker the average load on several motors in machine shops has been only about one-third of the rated capacity of the motor. It is interesting to note that in tests made at the Baldwin Locomotive Works it was found that with a total motor capacity aggregating 200 horse-power, a generator of only 75 kilowatts was sufficient to furnish the current, and ordinarily only 60 kilowatts, or 40 per cent., was required. At the present time there are in use at these works upwards of 300 motors, with a combined total capacity of 2,200 or 2,300 horse-power; whereas the generator output is only about 500 kilowatts.

Under those conditions, where the driven machines are not greatly over-motored, we may assume a motor efficiency of 80 per cent., which may be less or greater in individual cases. The combined efficiency, then, of generator and motor working intermittently with fluctuating loads will be about 60 per cent. of the power delivered to the engine.

For greater distances than those which obtain in plants of this character the loss in transmission will be greater, and higher voltage must be employed in order to keep down the line loss. While it is possible to put in conductors sufficiently large to carry the current with any assumed loss, yet the cost of the line becomes prohibitive with low voltage.

Where cheap fuel is available it is found in most cases that electric power can be generated at the works more cheaply than it can be purchased from a central station; especially is this the case if the exhaust steam be used for heating purposes. In isolated plants the cost of transmission is very small as compared with the total cost of generation; whereas in the average central station the cost of transmission, which includes interest and depreciation on pole line, usually constitutes a large percentage of the operating cost.

In those localities where the cost of fuel is high, electric

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power can often be purchased more cheaply from a central station which obtains its power many miles distant and transmits it electrically to a convenient distributing center, where it is used for power and light.

The recent development in electrical transmission is very marked, and one constantly hears of some new achievement more wonderful than anything previously accomplished. Distances have been gradually increased until it is now possible to transmit electrical energy economically and in commercial quantities up to 150 and even 200 miles.

There has been a steadily increasing tendency to raise the line voltage in such transmissions, and to-day we find in successful operation voltages as high as 40,000 and even 60,000 as compared with the 4,000 and 6,000 volts of a few years ago.

As pointed out by Mr. A. D. Adams,* so far as present practice is concerned the limit of use of high voltages must be sought beyond the transformers and outside of generating and receiving stations. As now constructed, the line is that part of the system where a final limit to the use of higher voltages will first be reached.

In order to avoid the temporary arcing and leakage between the several wires it is necessary to place the wires a considerable distance apart, which, with higher voltages, may lead to a modification in construction of pole line. The plan of substituting a series of steel towers about 90 feet in height and 1,000 feet apart is being seriously contemplated.†

In this case it is proposed to suspend the wires from tower to tower and separate them about nine feet apart. While expensive in first cost, it is thought that the satisfactory working of the system and freedom from breakdown, with the low maintenance and depreciation charges involved, would warrant the investment.

A more serious difficulty is found in the insulator, which is generally looked upon with distrust for the higher voltages

*Eng. Mag., October, 1902.

†Geo. H. Lukes in Trans. Assn. Edison Illuminating Companies, July, 1902.

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in use to-day. With a more perfect insulator there would appear to be no good reason why the present maximum voltages should not be exceeded.

The possibility of electrical transmission thus permits of the utilization of available sources of power at great distances from the center of distribution; but while it is interesting to know that a certain amount of power may be transmitted a given distance with a high degree of efficiency, it is more important to know whether the same amount of power could be obtained at the objective point more economically by other means.

It has been suggested that the future of long-distance transmission depends largely upon the development of oil as a fuel; but at the present time the outlook for oil fuel in general competition with coal or long-distance transmission is not encouraging; while the development of the Texas and Southern California oil fields has increased the visible supply and brought about increased activity in the use of liquid fuel, yet it is doubtful whether the advantages would be sufficient to cause it to come into general use as a fuel, since with a limited production and an increased demand for this and other purposes the cost would be correspondingly increased.

A number of railroads contiguous to the oil-producing centers have equipped their locomotives to burn this fuel, and it is used to some extent to fire marine boilers, and with great satisfaction; since its displacement for a given heating value is only about one-half that of coal, and the labor cost is materially reduced.

It is also used quite extensively in certain sections of the country as a steam producer in power plants, but it is hardly probable that liquid fuel will be a serious competitor of coal, notwithstanding its many advantages. At the present time, as far as power for manufacturing plants is concerned, it is largely a question of transportation, whether oil can be laid down and handled at a given point more cheaply than coal. It is probable, however, that oil fuel will supply a local demand in certain sections where transportation charges, and

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possibly insurance, will permit its use at a low cost, and it is in this connection that it may become a competitor of electrical transmission.

One interesting phase of the power problem which forcibly presents itself to the engineer at the present time is the vast possibilities possessed by the modern combustion engine, which includes the various types of gas- and oil-engines. While its use as a motor in industrial establishments has been somewhat limited, yet there is a marked tendency to employ the gas-engine in manufacturing works, and a consideration of its advantages and cost of operation, together with its high thermal efficiency and possibility of still further improvement, indicates that, for a great many purposes, both steam-engines and electric motors may be ultimately replaced by gas-engines.

While the first cost of electric motors in the smaller sizes is considerably less than the cost of well-made gas-engines for similar capacities, the saving during the first six months of service, due to the more economical operation of the gas-engine, will often more than compensate for the difference in first cost.

That the gas-engine in both large and small sizes has reached a point in its development where it can fairly rival the steam-engine in reliability and satisfactory running qualities there can be no question. In point of fuel economy, a gas-engine of moderate size is on a parity with the largest triple-expansion steam-engines, and will give a horse-power on less than one pound of fuel.

The high price of gas in this country has contributed largely to those causes which have prevented a more common use of the gas-engine as a motor. For this reason the gas-engine has generally been used, not so much because of its high efficiency as a thermodynamic machine, but rather on account of its convenience and saving in labor. It is true that natural gas is cheap, but it is equally true that natural gas is not generally available.

It is to producer gas that we must look for any marked increase in the use of the gas-engine. Fortunately the manu-

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facture of producer gas has reached a high state of development, and there are now in successful use several processes by which power gas can be made from cheap bituminous coals as well as anthracite and coke. The leanness of such gases renders them less effective per cubic foot of gas, as compared with the richer coal gas or even water gas; but this difference is more than compensated for by the low cost of production. It is upon such power gas that the commercial future of the gas-engine as a general motor depends.

A prominent factor in gas-engine practice which has attained a high degree of development in European practice is the small gas producer. These generators are very simple in operation and furnish a convenient and economical means of obtaining power at a much lower rate than with the ordinary city lighting gas. Generally small anthracite coal or coke is used, but several methods employ bituminous coal, lignites or wood. With bituminous coal, means must be provided for removing the tar and ammonia and other products of distillation.

The process of generation in some of the more recent producers is entirely automatic and depends upon the demand of the engine, so that no storage capacity is required. The economy of these small producers is shown by tests which give one horse-power on a sixteen horse-power engine with a consumption of only 1.1 pound of fuel. For engines above forty horse-power one horse-power can be obtained on seven-eighths pound of fuel.

The gas-engine industry received a signal impetus when it was discovered that blast furnace gases could be readily utilized direct in combustion engines without the intervention of boilers and without any special purifying processes. A still more important circumstance which is far-reaching in its results is the fact shown by Professor Hubert, of the Liége School of Mines, that the superior economy of the gas-engine enables equal power to be obtained with 20 per cent. less consumption of furnace gas than was formerly used in the generation of steam.

The successful employment of large combustion engines

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in this way utilizes vast sources of power which a few years ago were allowed to go to waste or at most were used very inefficiently.

The high thermal efficiency of the gas-engine has long been recognized and the possibility of further development is a promising factor in this field. The already accomplished efficiency of 38 per cent. reported by Professor Meyer, of Göttingen, greatly exceeds the maximum theoretical efficiency of the steam-engine and more than doubles its actual best obtainable working efficiency, but the end is not yet.

With higher compression even greater efficiencies may be expected. But with high compression there is danger of premature explosion, due to the generation of heat in compressing the gas in the presence of oxygen; for this reason Herr Diesel compresses the air separately. Under a pressure of five hundred pounds or more, which is used in the Diesel motors, the air becomes very hot and readily ignites a charge of liquid fuel which is injected into the compression chamber. There is no explosion; combustion occurs while expansion goes on, and the heat generated disappears in the form of work.

Efficiencies of 30 per cent. or more have been obtained with blast furnace gases which contain a very small percentage of hydrogen, and this with the high rates of compression which can be carried has led to the advocacy of non-hydrogenous mixtures in large engines. Certainly very high rates of compression may be had with a non-hydrogenous producer gas without fear of premature ignition, and it has the additional advantage of economical production.

The practice of making the cylinder in combustion engines act alternately, first as air compressor then as motor, has the advantage of greater simplicity, but it means immensely larger engines for the same power, since the number of effective impulses is thus cut in two.

The danger of pre-ignition and consequent severe shock on the engine also necessitates very heavy construction in the smaller engines in order to obtain a reasonable degree

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of safety in operation. Moreover, the smoothness of action is greatly retarded with this form of engine, especially if the governing is controlled by the "hit-and-miss" method, in which the regulation is effected by varying the frequency of the explosions, thus causing great variations in the driving torque.

Various expedients have been employed to overcome these defects, such as the use of multi-cylinders and different methods of control, but the size and cost of engine have been increased rather than decreased. Notwithstanding these well-recognized defects in the four-cycle type of engine, it constitutes by far the largest class in use to-day of what may be called successful gas-engines.

More recently very satisfactory results have been obtained in the construction of two-cycle engines. In some of these we find separate pumps employed to compress the charge of gas and air, which ignites and burns as it enters the cylinder. Higher compression is thus obtained without fear of pre-ignition, and this permits smaller clearance spaces with attendant advantages.

If the engine is single-acting, an impulse is obtained every revolution, which thus insures better speed regulation, as well as double the power for a given sized cylinder.

The highest thermal efficiency yet attained, namely, 38 per cent., has been secured with a two-cycle type of engine, which compresses the air and gas in separate pumps to a nominal pressure of eight or ten pounds; the air under this pressure being used to scavenge the cylinder toward the end of expansion. After the unconsumed products of combustion have been forced out by the fresh air, the cylinder walls having been cooled thereby, a charge of gas is admitted and compressed to a pressure of 150 to 175 pounds per square inch and then exploded, as in the usual method. This engine is double acting and receives a charge each side of the piston; thus two impulses are received each revolution, in a manner precisely similar to that of a steam-engine.

Whether these engines will be as satisfactory for small motors remains to be seen. It is possible that the greater

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complication of details in the two-cycle types, as compared with the simpler four-cycle engine, will cause the latter to continue to give the greater satisfaction, at least for the smaller sizes.

At the last meeting of the British Association, Mr. H. A. Humphrey gave some interesting data concerning recent gas-engines, and the record is both remarkable and significant. The limiting size has rapidly grown during the past two years, as shown by the fact that one manufacturer is now constructing a gas-engine of 2,500 horse-power and is prepared to build up to 5,000 horse-power.

The development of the large gas-engine is closely connected with the evolution of the fuel gas processes, and it is noteworthy that the first gas-engines in England above 400 horse-power were operated with producer gas, while many of the large gas-engines in Europe have been built for use with blast furnace gas.

In August of this year (1902) two leading English manufacturers had delivered or had under construction over fifty gas-engines varying in size between 200 and 1,000 horse-power; but we have to look across the channel for still greater achievements in this direction.

Neglecting all engines below 200 horse-power, we note that a classified list of gas-engines in use or under construction shows the remarkable total of 327 gas-engines capable of supplying 182,000 horse-power. This gives an average of about 560 horse-power per engine.

As compared with this we find from the last U. S. Census Report that, during the census year 1899, there were constructed in the United States 18,500 combustion engines having a total capacity of 165,000 horse-power, or only about 9 horse-power per engine.

Although this country has lagged somewhat behind Europe in adopting large gas-engines, there is evidence that this state of affairs will not exist very long, for a number of enterprising firms are already in the field prepared to build gas-engines up to any required size. One firm has already sold over 40,000 horse-power of large engines, most of them 2,000

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horse-power and several of 1,000 horse-power. Another firm has recently built two 4,000 horse-power gas compressors and also a number of 1,000 horse-power gas-engines.

The use to which these large engines are put is about equally divided between the operation of blowing engines for blast furnaces and the driving of dynamos for general power distribution; the tabulated list compiled by Mr. Humphrey for engines of more than 200 horse-power shows 99,000 horse-power for driving dynamos for light and power and 83,000 horse-power for other purposes.

While the gas-engine in the larger sizes is thus used extensively for the generation of electric light and power, a growing tendency is observed to use the gas-engines direct as motors.

A number of railroad and other machine shops have been equipped with moderate sized gas-engines suitably located about the works, and in addition, thousands of horse-power are used in the smaller sizes for a wide variety of purposes, including village water-works, isolated lighting stations, and manufacturing plants of all kinds.

With the possibilities of high thermal efficiencies we may look with much hope upon the still higher development of cheap fuel gas processes that will bring the gas engine into very general succession to the electric motor for many purposes, for it will doubtless be found that gas transmitted from a central gas-making plant at a manufacturing works into engines located at points of use will effect a material saving in the utilization of power over any existing methods.

It is not to be presumed that the gas-engine will displace either the electric motor or the steam-engine; each has its legitimate sphere of usefulness, and each will be more highly developed as the result of direct competition. Yet the economies already obtained indicate that the field of the gas-engine will be extended more and more into that of the steam-engine and the electric motor.

Many of the questions involved in this consideration are at the present time in a transitional stage. The reciprocating steam-engine has reached a high state of development,

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but it is not probable that it has attained its highest degree of perfection. While an economy less than 9½ pounds of steam per horse-power hour has been obtained, even better results may be anticipated; the use of high pressure superheated steam in compound, jacketed engines involves more perfect lubrication, and this may demand modification in existing valve types; however this may be, the outlook is promising for still higher efficiency; whether this will mean cheaper power than can be obtained in other ways will depend upon many conditions.

In any case, and especially with intermittent or variable loads, it is not so much a question of maximum efficiency as it is economy of operation.

From this point of view the present activity in the construction and development of the steam-turbine is of interest to engineers and power users. The steam consumption of a modern steam-turbine of moderate size compares very favorably with that of the better class of large reciprocating engines, but what is of greater importance is the evident superior steam economy under variable loads. The steam consumption per horse-power hour varies little from one-third to full load; at over-loads the economy, as shown by numerous tests, may be even better.

This feature predestines the steam-turbine to the special field of electric lighting and power generation, where it must inevitably become a formidable rival of the larger-sized, slow-speed reciprocating steam-engine.

It is a significant fact that immediately following upon the installation of the large 8,000-horse-power compound steam-engines at the central station of the Manhattan Elevated Railway, New York, we find three 5,000-horse-power steam turbines under construction for the Rapid Transit Company, of New York.

The high rotative speed of the steam-turbine is a prominent factor in favor of its adoption in connection with electrical generators, since the cost of the generator end of the equipment ought eventually to be very materially reduced; but for many lines of work the high rotative speed of the present

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types of steam-turbine is prohibitive, nor can it be adapted successfully to belt driving, except by the use of gearing. However, it is fair to presume that the present limitations of the steam-turbine are not insuperable, and that the attention which is now being given to its development will evolve a more universal type of motor adapted to general power purposes with large and small units alike.

The economies already obtained with both the steam-turbine and the gas-engine have brought each into a prominence which is at least suggestive of the important developments that are taking place in methods of obtaining and using power.

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[The following papers were read before the Geological Society of America and Section E, in joint session.]

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ADDRESS

BY

CHARLES C. NUTTING,

VICE-PRESIDENT AND CHAIRMAN OF SECTION F FOR 1902.

THE PERPLEXITIES OF A SYSTEMATIST.

A former Chairman of this Section gave utterance in his retiring address to the following frank expression of sentiment: "So welcome to the old-fashioned systematist, though his day be short, and may he treat established genera gently!"

If this cheerful prognostication is to be realized, the perplexities of the systematist are of short duration at best, or worst, and it were better for us, in view of our impending doom, to come before you to-day with the historic "Morituri te salutamus," and then kindly but firmly retire to the oblivion so imminently before us.

But on second thought we find ourselves not at all in the mood to fulfil the expectations of the genial oracle referred to, and, indeed, very much alive and willing to continue in the struggle for existence, although an even worse fate than death is offered as an alternative when the same prophet predicts that "the future systematic work will look less like a dictionary and more like a table of logarithms." Of course there is no gainsaying the fact that those who prefer logarithms will have them, but I will also predict that the number who will choose the lesser evil of the dictionary will remain for an indefinite length of time very much in the majority, even if this choice dooms them to the outer darkness where the "old-fashioned systematists" are to be relegated by the logarithm proposers.

However this may be, certain it is that there will always be need for the men who perform the hard and often thank-

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less task of the systematist, and those of us who are still pushing forward in spite of the almost overwhelming perplexities of the work, to say nothing of the frankly expressed contempt of the men in whose service we toil, are by no means called upon to sing our "Nunc dimitis." It has occurred to me that it would be profitable for us to consider on this occasion the position in which we stand, make confession of our sins, which are many, state as clearly as possible the embarrassments which at times nearly overcome us, and attempt at least to point out some of the means by which we can better our position and our work.

As to our position before the general public, it must be confessed that the general public cares for us not at all. Of all departments of biological science, none offers so little that is attractive to the average man as that which has to do with classification and the host of outlandish names that the systematist delights, in popular opinion, to inflict upon the literature of his subject. The average college student agrees with the general public, and will be prone to elect anything rather than systematic zoology or botany. There is absolutely nothing that seems to him more hopelessly dull, forbidding and profitless than all matters pertaining to classification and nomenclature. But it is in the house of our friends that we are wounded most cruelly. Even the best of our fellow zoologists and botanists wish us nothing better than a speedy and painless, at any rate speedy death, and the worst of them would be glad to hasten the day.

It is not my purpose to discuss at present the attitude of the general public, nor even that of the college student, important as it is to all of us, but some attention ought surely to be paid to the prevalent opinion of our colleagues.

Let us inquire, then, briefly, into the reasons for the unfortunate attitude of these who ought to be our best friends. In my opinion the most fundamental cause for their discontent is to be found in their irritation in finding nothing fixed or definitely settled in our classifications, or even in specific or generic names.

It certainly does not conduce to the tranquility of mind of

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the morphologist who desires to discuss the variation of a certain structure in a given group of animals to find that his friend the systematist is utterly unable to delimit the group for him, or that no two authorities can agree as to the number of species, much less as to their names! Wishing to get upon some solid ground for his discussion, the morphologist asks in desperation: "What is a species, anyhow!" And the systematist, if he is honest, is forced to admit that he doesn't know. Again, the morphologist, with a commendable desire to learn something of the classification in a general way, laboriously masters some scheme which seems to have met with general acceptance, only to find that the next authority that he consults scorns it utterly. Still again wishing to discuss the geographical distribution or ecology of some limited group, he finds that no two systematists agree as to the number of species included or the names by which they should be called.

Now, all this is exasperating to the last degree, and we must deal gently with our friends who exclaim in desperation: "Is there anything definitely settled in regard to any group of animals whatever?" or "Have the systematists any real basis for their decisions, or are they anything better than the merest personal whims?" Can we wonder that they resort at times to absolute brutality and propose logarithms?

Having thus admitted the unfortunate position in which we stand before our fellow zoologists, let us now turn our attention to the highly edifying endeavor to honestly confess our sins. I suppose that every zoologist who does systematic work starts out with the idea that there is nothing else quite so desirable and altogether ecstatic as the discovery and naming of new species; and this feeling results, it must be confessed, in numerous synonyms and great confusion. That this is an almost inevitable phase in the career of the ambitious systematist must be frankly acknowledged, and must be endured with as much philosophy as possible, the prospect being cheered by the reflection that the phase is exceedingly evanescent, and is of inconsiderable duration as compared

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with the whole career of the systematist. I know that I shall be backed by every worker of experience when I assert that any systematist who has gotten beyond the callow period would very much prefer to be able to place a given form in a previously described species than to be forced to describe it as new.

Besides, those of us who are sufficiently unregenerate can take great comfort in the thought that no one more eagerly embraces the chance to describe a new species than the morphologist who thinks he has discovered a novelty, and he it is who most often dodges the necessity of careful research along bibliographical lines, and at the same time artlessly evades all proper responsibility for his crimes by the formula: "If this interesting form proves to be new, I propose for it the following name."

The naive innocence of some of our embryo naturalists is sometimes quite refreshing. For instance, a year or so ago a young and enthusiastic student in a western State wrote me that he thought he had a new species of a group in which I am interested, and asked me to kindly send him the literature on that group. Not finding me able to see my way clear to accommodate him, he proceeded to describe the supposed new species, and gave it a name. The result proved that the name was pre-occupied and that the species was only a somewhat common color variety of a well-known form.

We have all of us made ridiculous mistakes, however, and no systematist of any experience could afford to throw the first stone were the biblical condition enforced. We should be cautious, however, and not leave too many cracks in our harness to be discovered by our friends the enemy. There are certain things that we ought to stop doing, and stop at once. One of the worst sins of the systematist is inadequate description of species. The scientific world has a right to demand good clear descriptions, and is not slow to express its contempt for any remissness in this direction. As an example of this particular sin I would cite an instance given by an entomological friend, which I quote verbatim:

"The variety harrisii of *Cicindela sexguttata* is described

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thus: It differs from typical *sexguttata* in the color, which is olivaceous green, and *in living at a considerable elevation.*"* It is not often that the variety maker is so refreshingly frank as this.

Another illustration is furnished by one of our energetic and intrepid young ornithologists, who evidently believes that each geographical locality ought to yield a trinomial for each bird inhabitant. He says:

"The differences characterizing this new form are not such as may be graphically described, but they are, nevertheless, quite apparent on comparison of specimens."

It appears from the context that this subspecies is based on a single specimen, but, coming from a different region, like the "living at a somewhat higher altitude" of the insect referred to above, seems to be in reality, if not professedly, a zoological character. It seems to your speaker that a difference that is so elusive that it cannot be graphically described is not a proper basis for even a new subspecies.

The question here arises: Is there any legitimate limit to the refinement of description and niceties of distinctions between species or subspecies? There are many that hold that any difference whatever is sufficient basis for a specific description so long as there is no intergradation with other forms. Now it is evident that differences may be so small that intergradations are practically, although not theoretically, impossible. The keen eye of the expert systematist becomes almost microscopic in its function and sees differences that appear perfectly evident to the observer, but that are really intangible to the general zoologist, to say nothing of the scientific public at large. Should each of these microscopic differences be dignified with a separate name? If so, can we wonder that the non-systematic brother becomes thoroughly disgusted with our discussions of the zoological "filioque" and consigns us all to quick extinction or a lurid future of logarithms?

It is to be hoped that the future will disclose some method

* The italics are mine.

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of preserving scientific exactness, and at the same time obliterating the excessive pedantry that at present seems to be the main objective with certain systematists. And there is good biological ground for this hope in the law enunciated by our lamented Cope as the "law of the unspecialized." This, he says, "describes the fact that the highly developed or specialized types of one geologic period have not been the parents of the types of succeeding periods, but that the descent has been derived from the less specialized of preceding ages," There is no doubt that the extremists have their time and their uses, but they are not likely to be followed in their extreme positions by their successors of coming generations. It may be confidently predicted that the future will disclose a safe mean between the lax methods of many of the older zoologists and the indefensible hair-splitting of the extremists among the so-called advanced systematists of to-day.

In the estimation of the general scientific public the most grievous of our sins is the making of synonyms, and there is no question that we have much to answer for in that direction. There are few, however, that are in a position to realize the difficulties, amounting almost to impossibilities, that confront even the most conscientious worker. He has in hand a form that he cannot place in any known species, although he would be saved a deal of trouble if he could. He must call this troublesome animal something. He cannot call it by an old name and so, perforce, he must find a new one for it. It belongs to an old and well-established genus to which hundreds of species have, in the course of more than a century, been referred. Every descriptive term that can possibly be made to apply to such an animal has long ago been used. Though the worker may live in some great library center, such as Boston or Washington, it is impossible for him to have access to all of the literature pertaining to even a limited group. Though he spend months in looking through dealers' lists and catalogues, he is bound to miss a number of papers, any one of which may contain matter vital to his purpose. Having exhausted every available source of information, he at last ventures to decide on a name which seems to him to be apt,

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and not preoccupied. The more experienced he is as a systematist the less confidence he has that his name will stand, nor is he greatly surprised to be reminded by some loving friend that that name was used twenty years ago in a paper published in Russian and issued by a local scientific society in Kamchatka.

To illustrate the hopelessness of consulting all of the literature on even the most limited subject I will venture on a bit of personal experience.

For the past ten years I have earnestly endeavored to consult all of the papers regarding a very small group of animals in which I am particularly interested. In addition to buying everything that was mentioned in numerous lists and catalogues from the best European book dealers, the libraries of Harvard, the National Museum, the Congressional Library, the private library of Dr. Agassiz at Newport, the library of the Naples Zoological Station and other famous libraries in Europe were faithfully consulted and a card catalogue of every reference to a species included in the group under consideration was made. After which it seemed that I could at last work with some confidence that nearly all of the possible synonyms were where I could get at them when wanted. A few weeks ago the mail brought me a paper published in Geneva, in which occurred no less than one hundred titles of papers relating to the group of animals in which I had been working, not one of which I had been able to find.

Now if it is so difficult, nay, impossible, for one who has access to a number of the best libraries to feel confident of avoiding the creation of synonyms, how can we expect the young worker with access to only a few books to avoid the same catastrophe? Of course, it is easy to say that he has no business to attempt systematic work, and perhaps we should be justified in such a remark. But, after all, our position would be sadly like that of the historic mother who forbade her daughter to go near the water until she had learned to swim.

There is a distinct danger in attempting to restrict syste-

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matic work to those exceptional persons who have access to first-class libraries. Thoroughly equipped systematists will be needed in the world for a long time to come, in spite of frankly expressed views to the contrary, and the ranks of those passing away must be filled by competent men. Such men must be supplied mostly from our colleges and universities, and it is futile to expect the few institutions having adequate libraries to turn out a sufficient number of men to do this work.

As a matter of fact, the very universities that are in the best position to do such work are the ones that offer the least encouragement to the would-be systematist. In my opinion our best-equipped universities are falling far short of their proper function in not paying more serious attention to this part of biological science. Some time ago I received a letter from a zoologist holding a high position in one of our largest museums, in which he complained that, while they were able to find plenty of young men who could work out the histology of a definite organ, or the embryology of a species or undertake experimental work, there was only one university that he knew of, and that a western one, that gave students the training that was necessary to make them competent to work up a collection. For years there have been waiting for suitable men the vast accumulations of material in our great museums, and it is impossible to find men able to work up some of the most important groups.

Such, then, is the situation. There is the most urgent need for competent systematists, and our universities, the natural source of supply, are doing next to nothing in the way of training men for this important work.

But the objection may here be raised that the systematist is a specialist of a kind that cannot be trained for his work in the ordinary university course.

Of course, it is impracticable to turn out full-fledged systematists, but it is practicable to give men the kind of education that will enable them to take up systematic work to advantage after their college days have been completed. The mental or intellectual equipment needed by the system-

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atist includes three prime requisites: (1) accurate observational power, (2) a well-trained and reliable power of discrimination, and (3) the power to describe accurately and in good English. Now, be it observed that these three accomplishments are the very ones that are the most valuable intellectual gifts in almost any walk in life, and hence it follows that that sort of education which turns out good timber for systematists is the very one that serves the best and most useful pedagogical purposes; and the plea which I here make for more attention being paid by our colleges to preparing men for systematic work, is at the same time a plea for the best and strongest preparation for almost any walk in life.

It will, of course, be conceded that the first of the requisites cited above, namely, accurate observational power, is the primary aim of work in all material science; and it will also be conceded that the education of the power of discrimination or judgment is also included in any thorough scientific work; but I do not believe that any other branch of biological science does so much toward evoking fine descriptive power as does systematic work, either in botany or in zoology. After an experience of some seventeen years as a teacher of science, it is my deliberate judgment that good descriptive ability is much more rare than the ability either to observe or to discriminate, which is really a part of observation. It would be laughable, were it not pathetic, to see the utter helplessness of even the better class of university students when they are told to describe even the simplest object: Time after time I have found that a class of twenty or more sophomores did not contain a single one who could really describe any definite object with even approximate success. But it is a never-failing delight to see the power that they can acquire in this direction after a year of faithful work along systematic lines.

Teaching of the sort that I have indicated need not be confined to the largest and best-endowed colleges. Fairly large collections in certain definite groups are a necessary prerequisite, but such collections can be secured at less

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expense than the laboratory equipment that includes a good compound microscope for each student, and in many cases the teacher can, with the help of students, make suitable collections in such groups as birds and insects.

The whole scheme of systematic arrangement lends itself admirably to the gradual evolution of descriptive power. Commencing with the larger groups, the student is drilled in discriminating the broader characters, such as differentiate classes and orders, for instance; then closer work is required in studying the families. Lastly, some few families are taken up and the work becomes focused on the fine discriminations required in describing genera and even species.

In the University of Iowa, for instance, the student works for one-third of a year on the classes and orders of the lower invertebrates. Then he studies the groups of mammals, down to and including the families, for an equal length of time, the remainder of the collegiate year being devoted to the study of birds, more than half of this latter period being given to a careful study of the Passeres. The work is focused more particularly on birds because the university museum is particularly well equipped in birds; they are pleasing objects of study for most students, and they are particularly available for illustration in such objects as coloration, geographical distribution and, strange as it may seem, ecological problems.

You will pardon me, I hope, for thus intruding the work of my own department upon your attention. But it serves to illustrate my meaning in claiming for systematic work the highest grade of pedagogical value. It does teach the student to observe carefully, discriminate with something of that judicial nicety so rare and so helpful in any life, and lastly—and it seems to me that this is the crowning achievement in education—to describe accurately not only from a scientific but also from a literary standpoint. Lucidity and accuracy of language accomplish marvels in the way of inciting to lucidity and accuracy of thought, and, so it seems to me, actually precede them in time.

All this may seem a digression from the main theses of

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my address, but it will be remembered that we are trying to find a remedy for the scarcity of men competent to occupy the field of systematic work, and the first thing needful is a realization on the part of our colleges and universities that they have too long neglected the educational value of training along systematic lines. Were they led to recognize this at its just value, it would be provided for on at least an equal footing with morphology in the curricula of all reputable colleges, and this would result in the graduation, yearly, of a number of young men and women who have the preliminary training that will enable them to take up systematic work in earnest.

Of course, this real systematic work can only exceptionally be done in colleges. Not even as post-graduate work can it be attempted, save under circumstances seldom realized. But the men, if worthy, will find the place to work in centers where great museums and libraries will be at their command. In this connection the thought forces itself to the fore that the great and greatly discussed Carnegie Institution can do a most important work in seeing to it that such young men, equipped particularly for systematic work can receive enough of a stipend to feed and clothe them while necessarily away from home and doing important systematic work in overhauling and bringing order out of the chaos that prevails in most if not all great museums, where a wealth of material has been allowed to accumulate for decades awaiting the time when the right man can come to the aid of overworked curators and intelligently and efficiently disentangle the all but hopeless masses of material, and, with keen insight and trained powers of description, successfully trace the obscure web of relationships and of descent. Thus the curators will be left free to do better and more worthy work along the lines of their chosen studies, relieved of at least a part of the all but intolerable burden under which they are staggering, and in spite of which so much excellent work has been done.

While no one more heartily condemns scientific provincialism than does your speaker, still we can rightly indulge the

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hope that the time will come, and that soon, when it will be unnecessary to send to Europe for men competent to report on collections made by our Government expeditions, and when collections will be entrusted to American zoologists, *not* because they are American, but because they are best able to do the work in a satisfactory manner.

It is probable that nine out of ten systematists, if asked what, in their opinion, was the most thankless and wearying part of their work would unhesitatingly answer, "The bibliographic work." In nothing are our energies so wastefully and often needlessly expended. Now that the Congressional Library is at last in working order, it seems to me that it ought to be possible to undertake a work in this direction that would be not only an unspeakable boon to all who are engaged in systematic investigation, but also to the scientific public at large; for nothing that I can think of would go so far towards reducing the pernicious activity of the maker of synonyms to a minimum as a methodical and exhaustive publication of bibliographies in connection with which synonyms* would be promptly "spotted" and reported at once to the scientific world.

Our Congressional Library is worthy of a nation's pride. Having had occasion to work there myself, I can say that nowhere can better service or more helpful courtesy be found than is accorded one who desires to do serious work within its walls. One must use it before he can form any just idea of the wonderful change that has been brought about since the present building was completed. Here is undoubtedly the best place in America to do bibliographic work, and here could be undertaken a public service that would be second to none in helpfulness to the naturalist, the systematic publication of bibliographies, perhaps following the general lines of the Concilium Bibliographicum, which has already rendered invaluable service, so far as current publications are concerned.

The Concilium Bibliographicum, however, can furnish but

* The word synonym is here used in its more general sense, including both autonyms and synonyms in a strict sense.

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little help regarding publications of other than comparatively recent date, and this is the most pressing need of the systematist. This task, colossal as it is, could be accomplished if attacked systematically by a sufficiently large force of competent workers. It would not be necessary to complete the work in any group before the results could be available for general use. By a periodical mailing of cards some relief could very shortly be extended to all those who are known to be interested in any group, and as the history of our science covers less than a century and a half, a vigorous prosecution of the work would enable us to have authentic and reasonably complete bibliographies brought up to date within a very few years.

Such work need not, indeed should not, be confined to bibliographies of publications, but should include bibliographies of specific names. Every reference to a species should be given a separate card. These could be arranged both alphabetically and chronologically, and when such a bibliography is completed up to date a synonym can be detected with unerring accuracy. I speak from some little experience when I say that such an arrangement of cards is the greatest possible assistance and time-saver, as I have myself made a card bibliography of a single order of animals with which I am working. It includes some six thousand cards, and involves a card catalogue of authors, with their publications, of families, of genera and of species.

Of course, such a plan as has been indicated could only be carried out by a corps of specialists, each having immediate charge of the work pertaining to some limited group, and the whole should be under the supervision of some public scientific organization such as the Smithsonian Institution, or possibly the Washington Academy of Science; such bodies being particularly available on account of their being situated in Washington, where most of the actual work would be done.

But what answer shall we give to our friends who plaintively implore us to "deal gently with established genera?" It is in connection with this question that we are confronted with some of the most perplexing of our difficulties. How

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far are we justified in overturning that which is firmly established by usage in order to introduce schemes of classification that seem to us better and more rational?

Hoping that your patience has not been exhausted by the references already made to personal experiences, I beg your indulgence while I refer once more, for illustration, to my own work, which is a monographic treatment of an order of cœlenterates. In attempting to discuss the genera of a single family, the Sertularidæ, it was found that there were included in it about twelve apparently well-established genera. These had been carefully defined and the classification seemed a logical and good one. When, however, the great amount of sertularian material accumulated during the past twenty years by the *Albatross* and other Government agencies, together with the results of recent work by our cousins across the water, came to be worked over, the fact became more and more apparent that not a single one of these established genera could hold, unless some entirely unnatural and arbitrary characters were used, such as would be employed in the construction of artificial keys. Not a single one of these genera, as defined, was exempt from almost ideal intergradation with one or more other genera. Here the investigator is confronted with a dilemma with several horns, if the bull be allowable, either one of which was fraught with most uncomfortable consequences. The following courses were open:

1. To adopt an entirely artificial system, for convenience only.

2. To throw all of the old genera into one, for the sake of scientific consistency.

3. To make a new grouping, involving a new lot of genera.

4. To use the old and well-established genera, pointing out the intergradations and frankly admitting their scientific insufficiency.

Considering these in order, we find that the first proposition, that is, to adopt an entirely artificial system for convenience only, would be eminently unscientific, a backward step that should not have serious consideration.

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To throw all the old genera into one would be the course to which the strict dictates of the scientific conscience would impel the investigator. If one could set aside every consideration save the letter of the law, and be willing to be pilloried by his colleagues, this would be the proper course to pursue. As a matter of fact, however, such a course would involve the renaming of about nine-tenths of the hundreds of species involved, and throwing all the knowledge so laboriously attained by our predecessors and contemporaries into pi, resulting in every worker in that group, or every one that wanted to mention a species, being forced to find out what the thing would be called under the new system, no matter how familiar he might be with the group. Should any one have the hardihood to precipitate such a disaster, he would not only be pilloried and execrated, but, I doubt not, would fail to secure a single follower, and all of his work would die with him and his name be anathema.

The third course, that is, to make a new grouping under new generic names when necessary, and old ones when possible, would be an excellent solution were it not for the fact that months of the hardest study, with ample literature and material hitherto unsurpassed in abundance has resulted in the sad conclusion that no grouping can be devised that will not be open to the original difficulty, that of intergrading forms in all directions. Nothing would be gained, and much confusion would result from this course, which, like the others, cannot wisely be adopted.

There remains then but one suggestion. That is to use the old and established genera, which will work in perhaps ninety-five per cent. of the cases, and frankly call attention to the intergradations so that no one will be misled.

In this way we can heed the pleading of our friends to "deal gently with established genera," and not bring disastrous confusion into the already overworked synonymy.

Of course, this solution is far from ideal, and will doubtless meet with no little criticism, but it is an honest one, and it is hoped will meet with the gratitude of those who plead with us to "deal gently with established genera."

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It is to be feared that we have been too lenient with those who have been heedless in the matter of overturning existing classifications before they are certain that they have something better to offer. The old proverb, "Be sure you are off with the old love before you are on with the new," is one all too apt to be forgotten by the enthusiasts who are unable to distinguish the difference between becoming great and becoming notorious. A little wholesome conservatism is by no means to be despised. A system of classification is not necessarily better because it is new, and we need to redeem ourselves from the charge, all too well founded, that we are capricious in tinkering with matters that need the most careful pondering, and an application of Davy Crockett's motto, "Be sure you're right, and then go ahead."

Of course, all real progress must be encouraged, and it will never do to allow considerations regarding public, or even scientific, opinion to deter us after we are sure we *are* right. Conservatism by no means means stagnation, but it does mean deliberation.

But I have already trespassed too long upon your time without even touching on several questions of vital importance, such as the "A. O. U. Code," the best medium of publication, an authoritative tribunal for the settlement of such questions of nomenclature as could rightly be submitted to such a body, and other matters that I had hoped to discuss.

In conclusion, let me urge the necessity of hearty cooperation and a good understanding between systematists and other workers in the field of biological research. None of us can afford a contemptuous attitude toward any other who is honestly striving to extend the limits of knowledge, even though his faults are many. In early days out West there hung in a popular dance hall the suggestive notice: "Don't shoot the orchestra. He's doing the best he knows how!" The same plea in thought, if not in language, we would enter in behalf of the systematist.

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PAPERS READ.

Tadpoles of the Green Tree Toad (*Hyla versicolor*) and Comparison with the Common Toad (*Bufo lentiginosus*). By Simon H. Gage.

The Habits of Cryptobranchus. By Albert M. Reese.

The Effect of Low Temperatures on Mosquito Larvæ. By John B. Smith.

Notes on the Natural History of some of the Nudibranchs. By W. M. Smallwood.

Sense of Hearing in Fishes. By G. H. Parker.

Breeding Habits of the Yellow Catfish (*Ameiurus nebulosus*). By H. M. Smith.

Death-Feigning in Sand Fleas. By S. J. Holmes.

Variation and Natural Selection in Lepidoptera. By H. E. Crampton.

A Review of Certain Attempts to Introduce the Eastern Oyster into the Bays on the Oregon Coast. By F. L. Washburn.

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A Reconnaissance of Faunal Conditions in Jamaican Waters. By Hubert Lyman Clark.

The Phasmidæ, or Walking-sticks, of the United States. By A. N. Caudell.

The Morphology of Clasping Organs in Certain External Parasites. By Herbert Osborn.

Description of Four New Species of Grasshoppers, and Notes on other Orthoptera from Colorado, Texas, Arizona and New Mexico. By A. N. Caudell.

On a Small Collection of Crustaceans from the Island of Cuba. By William Perry Hay.

Evolution of the Proboscidea in North America. By Henry F. Osborn.

Some Questions as to the Arrangement of the Primates. By B. G. Wilder.

Primary Division of the Reptilia into Two Great Groups Phylogenetically Distinct. By Henry F. Osborn and J. H. McGregor.

Male Preponderance (Androrhopy) in Lepidopterous Insects. By A. S. Packard.

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The Decapod Crustaceans of the Northwest Coast of America from Alaska to San Diego, California. By Mary J. Rathbun.

Further Notes on the Heart of Molgula Manhattensis Verrill. By George William Hunter, Jr.

On the Morphological and Physiological Classification of the Cutaneous Sense Organs of Fishes. By C. Judson Herrick.

An Exhibit of Lantern Slides Illustrating the U. S. S. "Albatross" and Her Work. By C. C. Nutting.

The Eyes of a Specimen of the Cuban Blind Fish, Lucifuga and Those of Her Four Young. By C. H. Eigenmann.

Observations on Foot Prints in Beach Sand. By Herbert Osborn.

Faunal Characteristics of the Sandusky Region. By Herbert Osborn.

Protoplasmic Old Age. By G. N. Calkins.

The Structure, Development, and Function of the Torus Longitudinalis of the Teleost Brain. By Porter E. Sargent.

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AN UNUSUAL ATTITUDE OF A FOUR-WEEKS' HUMAN EMBRYO-COMPARISONS WITH THE MOUSE. BY SUSANNA PHELPS GAGE.

THE CRANIAL NERVES OF SQUALUS ACANTHIAS. BY OLIVER S. STRONG.

A DISSECTING PAN AND A SUBSTITUTE FOR BEESWAX. BY E. L. MARK.

WHITE FEATHERS. BY R. M. STRONG.

SOME REMARKABLE FOSSIL FISHES FROM MT. LEBANON, SYRIA. BY O. P. HAY.

THE BONES OF THE SHOULDER GIRDLE OF FISHES. BY THEO. GILL.

THE SYSTEMATIC RELATIONS OF THE FISH GENUS LAMPRIS. BY THEO. GILL.

[The following papers were read before the American Morphological Society and Section F in joint session.]

SOME RECENT CYTOLOGICAL INVESTIGATIONS IN THEIR BEARING ON MENDEL'S PRINCIPLES OF HEREDITY. BY E. B. WILSON.

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PROVISIONAL PROGRAM FOR CONTINUATION OF RESEARCHES ON CAVE FAUNA. BY C. H. EIGENMANN.

THE TORTUGAS AS A BIOLOGICAL STATION FOR RESEARCH. BY ALFRED G MAYER.

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ADDRESS

BY

DOUGLAS HOUGHTON CAMPBELL,

VICE-PRESIDENT AND CHAIRMAN OF SECTION G FOR 1902.

THE ORIGIN OF TERRESTRIAL PLANTS.

I should like to invite your attention for a little while to some of the factors that apparently have been operative in determining the changes which plant structures have undergone in the course of the development of the vegetable kingdom. While some of these are perfectly obvious, others are by no means so evident, and, as might be expected, there is not perfect agreement among botanists as to the relative importance of some of these factors, nor indeed of their efficiency at all.

I shall not attempt here to go into any extended discussion of the remarkable results obtained by Professor De Vries in his recent studies upon variation in plants. These are too important, however, to be dismissed without some mention. The conclusion reached by Professor De Vries is that, in addition to the variation within the limits of species, there may be sudden variations, or "mutations," which, so to speak, overstep the limits of the species, and thus inaugurate new species. While the results obtained, especially in the case of *Œnothera Lamarckiana*, are certainly most striking, more data are necessary before we can accept without reserve the conclusions reached. It is certain that marked changes—"sports," as the gardeners term them—often appear without any explainable cause, and it is equally difficult to understand, what, for want of a better term, we can only term "ten-

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dencies" to develop in special directions. Thus the specialization of the sexual reproductive cells, which has evidently taken place quite independently in several unrelated lines; the development of heterospory, and probably of the seed-habit in different groups independently, are hard to explain without assuming an innate tendency to vary in a determined direction.

It is not, however, with these exceedingly difficult and often obscure problems that we shall concern ourselves here, but rather with those changes in plant structures which are referable to more or less evident response to known conditions.

Speaking in broad terms, I think we can reduce the determining factors to three categories, leaving aside the inherent tendencies to variation. These three sets of factors are: (1) those relating to the food supply, (2) the relation to water, and (3) those concerned with reproduction.

It is hardly necessary to say that there is no fundamental distinction between plants and animals. At the bottom of the scale of organic life are many forms, especially those belonging to the group of Flagellata, which are intermediate between the strictly animal and vegetable organisms.

We may safely assume that the primitive organisms were motile, perhaps resembling some of the existing flagellates. Of the latter, some are destitute of pigment and approach the lower Protozoa; others are provided with chromatophores containing chlorophyll, and resemble the lower plants. It is highly probable that the forms with chromatophores are able to assimilate carbon dioxide, as the typical plants do, and may be denominated "holophytic." The forms without chlorophyll are probably, like animals, dependent upon organic food for their existence.

If we compare the holophytic flagellates with those forms which have no cholorophyll, a significant difference may be noted, which is evidently associated with their nutrition. The holophytic forms are noticeably less motile than the others. Thus *Euglena*, one of the commonest green flagellates, becomes encysted before division takes place. The resting cell has a firm membrane about it, and closely resembles a

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typical plant cell. The forms without chromatophores, however, *e. g.*, *Scytomonas*, may divide longitudinally in the active condition. This difference in motility between the forms with and without chromatophores, seems to be the first hint of the differentiation of the characteristically motile animals and immobile plants.

One group of plants (Volvocaceæ) evidently allied to the Flagellata, and sometimes even included with them, like animals, show active locomotion during their vegetative existence. Aside from these, and the Peridineæ, which may be remotely related to them, locomotion is exhibited only by such reproductive cells as zoospores and spermatozoids. The frequent reversion to the motile condition found in the reproductive cells, suggests the probability that these have been derived from similar ancestral forms.

The loss of motility in typical vegetable cells is associated with the formation of a firm membrane, usually of cellulose, about the cell. This precludes all movement of the cell, except in those cases where openings are present, through which extensions of the protoplasm, usually in the form of cilia, protrude.

The power of free locomotion was probably a character of the primitive vegetable cell, but with the development of the holophytic habit, this power has been lost by the vegetative cell of most plants. The loss of locomotion in plants may probably be connected with the development of the power to assimilate carbon dioxide, the main source of food. As the CO_2 in the air, or dissolved in water, is constantly being received, it is not necessary for the plant to move from one place to another in search of food, and we find plants becoming more and more stable. Where animals are so placed that their food supply is abundantly received, they may assume an immobile, plant-like habit. This is especially marked in many marine animals, such as corals, hydroids, sponges, ascidians and such molluscs as oysters. The old name "zoophyte" applied to corals and similar animals was not in all respects a misnomer. These rooted marine animals exhibit another resemblance to plants in the development of

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free swimming larvæ, analogous to the active zoospores produced by so many algæ. In both instances it is safe to assume that the motile stage is older than the fixed condition.

Lack of time forbids our consideration in detail of the very important, but by no means clearly understood, problems dealing with the evolution of sex in the vegetable kingdom. Thus the reason why the development of distinct sexual cells has taken place in an almost identical manner in several widely separated groups of plants, is hard to explain. The sexual cells, or gametes, have beyond question been derived from non-sexual ones. Thus in several groups of algæ, *e. g.*, Volvocaceæ, Confervoideæ and Phæophyceæ, there still exists an almost perfect series of forms leading from the non-sexual zoospores to perfectly differentiated male and female gametes. The formation of sexual or non-sexual reproductive elements is, in many cases at least, largely dependent upon the conditions under which the plants are grown. This has been very clearly shown by the remarkable series of investigations made by Professor Klebs upon various thallophytes. For a discussion of the meaning of sex, the reader may refer to the recent papers on the subject by Strasburger and Boveri.

In short, while we know to a considerable extent some of the factors which determine the formation of sexual cells, where these have already been developed, the reasons why sex has developed are still very obscure.

Secondary reproductive structures, such as sporangia, seeds, flowers, fruit, etc., are readily enough explicable and need not be dwelt upon here.

PHOTOSYNTHESIS.

Perhaps the most important physiological property of green plants is photosynthesis, or the ability to utilize the energy of the sun's rays for the manufacture of the primary carbon compounds necessary to build up living protoplasm. That some of the most striking modifications of the plant body are directly associated with photosynthesis is certain. The development of leaves in various groups of plants is, perhaps, the most obvious response to the needs for photosynthesis. The

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leaf is, *par excellence*, the photosynthetic organ. The spreading out of the green cells so as to offer the most favorable exposure to the light rays, and in the higher plants the development of stomata and the spongy mesophyll, or special assimilating tissue, are evident adaptations to photosynthesis. Leaves are by no means confined to the vascular plants, however. We need only recall the simple leaves of mosses and liverworts and the similar organs in the more highly organized seaweeds, such as *Sargassum* or *Macrocystis*. Even among the lowly green algæ simple photosynthetic organs may be developed. The dense branching tufts of *Draparnaldia* or the expanded frond of *Ulva*, for example, are of this nature.

The leaves of these lower plants are very different morphologically from those of the ferns and seed plants, but show very clearly that they are physiologically of the same nature; *i. e.*, they are *analogous* but not *homologous*.

Other special modifications associated with photosynthesis are the peculiar lacunar tissues found in the thallus of the Marchantiales and in the sporogonium of the true mosses and in *Anthoceros*. In all these instances there are formed, in connection with the green lacunar tissue, more or less perfect stomata. These upon the apophysis of the sporogonium of many mosses, and over the whole surface in *Anthoceros*, are precisely similar to those found upon the leaves and other green organs of the vascular plants.

While it is usually stated that, among the bryophytes, appendicular organs are quite absent from the sporophyte, the apophysis, or special assimilative organ at the base of the capsule in some of the more specialized mosses like *Polytrichum* and *Splachnum*, might almost be so regarded. In the latter genus it sometimes forms a broad disk several times the diameter of the rest of the capsule, and is just as truly a special organ for photosynthesis as is the leaf of a fern or flowering plant.

WATER.

Even more important than the changes of the plant body associated with photosynthesis are those which are due to the plant's relation to the water supply. All organisms require

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a certain amount of water in order that the protoplasm may perform its functions. Protoplasm is not necessarily killed by the withdrawal of water, but it is rendered inactive, as may readily be seen in such structures as seeds, spores, etc.

The lowest organisms, whether plant or animal, are virtually aquatic; for, although they do not necessarily always remain in a liquid medium, they become quiescent when moisture is withheld. Very many, like most algæ, are true aquatics, and it is safe to assume that the progenitors of the higher plants lived in the water. The nearest approach to these ancestral forms which have survived are probably certain green algæ, which have retained much of their primitive simplicity. Much the greater number of living plants, however, have given up the primitive aquatic habit for life on land. In adapting themselves to this new habitat they have contrived to exist with a much diminished water supply, which has enabled them to outstrip the much simpler forms which have retained their old aquatic habit.

The change from the primitive aquatic condition to the much more varied conditions of terrestrial existence is bound up with profound changes in the organization of the plant body.

MARINE PLANTS.

Of the existing plants which have retained the primitive aquatic habit, the most important are the various types of marine algæ, including not only the larger seaweeds, but also the minute pelagic forms like the diatoms and Peridineæ. Many of the larger seaweeds are very much better developed than the simple green fresh-water algæ, and show many special modifications associated with their peculiar environment. Not being subject to the drying up which threatens all fresh-water organisms at times, it is very rarely that marine algæ develop any form of resting spores such as are so common among fresh-water algæ. On the other hand, those which grow between tide-marks, where they are regularly exposed at low-tide, develop mucilaginous or gelatinous tissues, which prevent too complete loss of water. This is especially well seen

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in the large kelps and similar forms. Some of these, also, reach an enormous size, and develop leaves which are often provided with bladder-like floats, which bring them to the surface when they are exposed to the light.

Very characteristic are the minute pelagic plants, especially the diatoms and Peridineæ, which are important constituents of the plankton, or surface life of the sea. These floating plants are generally provided with some sort of buoyant apparatus, evidently an adaptation to their pelagic life. Small as these floating algæ are individually, they are immensely important to ocean life, as they constitute the main source of food for the hosts of animals inhabiting the sea.

The great subkingdom of Fungi offers many interesting problems bearing upon the evolution of plant-forms, but there is no reason to suppose that any higher types of plants have ever arisen from the Fungi, many of which are doubtless plants of comparatively recent origin. Most of their peculiarities are associated with their nutrition, which is entirely different from that of typical plants. Not having chlorophyll, they are, like animals, dependent upon other organisms for food. Consequently all fungi are either saprophytes, living upon dead organic matter, or as parasites they attack living animals and plants.

I cannot dwell here upon the extremely difficult problems connected with the origin and affinities of the fungi, even if I felt competent to discuss them.

THE ORIGIN OF TERRESTRIAL PLANTS.

We have now to consider what causes led to the abandonment of the aquatic habit by the algæ ancestors of the vascular plants, and how this radical change in their environment has influenced the development of the structures of the higher plants.

Nearly all fresh-water plants are exposed to destruction at times, by the drying up of the bodies of water in which they live, conditions which are never met with in the life of most marine organisms. This necessitates some means of surviving the periods of drought, and has resulted in the development

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of various devices for carrying the plants through from one growing period to another. While a few low aquatics, like *Pleurococcus* or *Oscillatoria*, may become completely dried up without being killed, in most fresh-water algæ there are produced special cells—spores—which are more resistant than the vegetative cells and survive the death of the rest of the plant body. These resting spores may be produced non-sexually, as in *Nostoc*, or the "aplanospores" of some of the green algæ; but more commonly they are the product of the union of sexual cells, or gametes, and may be generally denominated "zygotes."

This condition of things of course precludes growth, except when an abundant water supply is provided. It is evident that any device by which the vegetative life of the plant can be prolonged is an obvious advantage.

Some such contrivances, of a simpler kind, are seen in some of the lower green plants. Thus the gelatinous mass in which the filaments of a *Nostoc* colony are imbedded, or the "palmella-stage" of some Confervoideæ, offer a certain amount of resistance to the loss of water, and serve to prolong the period of vegetation. Less commonly root-like organs are developed, which enable the alga to live on the wet sand, penetrating into it and drawing up water from below. Species of *Vaucheria* and *Botrydium* exhibit this very well.

We may imagine that some algal form, perhaps related to the existing Confervoideæ, adopted a similar amphibious habit, developing rhizoids, by means of which it could vegetate on the mud after the subsidence of the water in which it was growing, in a manner analogous to that exhibited by certain amphibious liverworts still existing. The well-known *Ricciocarpus natans*, for example, lives first as a floating aquatic, but may later settle on the mud, as the water subsides, and there vegetates much more luxuriantly than in its aquatic condition.

The change from a dense medium like water to the much rarer atmosphere necessitates the development of mechanical tissues, to give the plant the requisite support in the air. There must also be developed devices for protecting the tissues against excessive loss of water due to transpiration.

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Other modifications are to insure economy of water in fertilization.

In submerged aquatic plants water is absorbed directly by all the superficial cells, and of course there is no loss due to transpiration. Moreover, special conducting tissues are much less important, and are either quite wanting, as in most algæ, or much less developed than in related terrestrial forms. As soon as a plant becomes terrestrial there must be provided organs (roots or their equivalent) for drawing up from the earth water to replace what is lost by transpiration, and in all but the simplest forms, special conducting tissues to facilitate its transport. In the lower types of land plants, the absorptive organs are usually simple hairs (rhizoids), but these are quite inadequate to supply a plant of large size, and consequently it is only those terrestrial plants which are provided with a true root system that have succeeded in reaching a large size. Even in the lower terrestrial forms the rhizoids do not monopolize the absorption of water, but many of them are able to absorb water directly through the leaves or through the superficial cells of the thallus. While this is especially marked in many mosses and liverworts, which are, so to speak, more or less aquatic in their behavior toward water, it is by no means confined to them, as most vascular plants develop structures, seeds, tubers, bulbs, etc., which can absorb water directly. Less commonly the leaves of vascular plants have this property. This is especially marked in various xerophilous plants, such as the Californian gold-back fern (*Gymnogramme triangularis*), *Selaginella rupestris* and other species, many species of *Tillandsia*, etc.

As all botanists know, the structural differences between aquatic and terrestrial plants are very marked, but there are some transitional forms which illustrate very beautifully the change from one to the other, and the efforts of the plant to adjust itself to the changed conditions. Thus some plants which are usually strictly aquatic, such as some water-lilies, may assume a nearly terrestrial condition, the long-stalked, floating leaves being replaced by those borne upon shorter upright petioles.

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The primitive aquatic plants are either unicellular or simple cellular plants with relatively little differentiation of parts, as might be expected in organisms living in a relatively uniform medium. A necessity for their active existence is an abundant water supply, as they are not provided with any adequate means for resisting desiccation, although the mucilaginous or gelatinous substances in which their cells are sometimes imbedded, serve to retard for a short time the loss of water by evaporation, when they are exposed to the air. A good many of the lower fresh-water organisms are capable of becoming dried up without losing their vitality, but of course their activity is stopped. More commonly they depend upon special resting cells, or spores, to carry them through periods of drought or cold.

In exceptional cases, the lower algæ may assume an amphibious habit, living upon wet mud instead of actually in the water. *Botrydium* and some species of *Vaucheria* develop a simple root system by which the loss of water by transpiration is made good so long as the soil remains moist; but these quickly die as soon as the mud dries, as their cells are not protected against loss of water by evaporation.

It is, however, among the bryophytes, or mosses, that anything approaching a satisfactory solution of the problem of a terrestrial existence is attained. (I am leaving out of account the fungi.) All of the mosses are, to a certain extent, amphibious, since all of them require first water in order that fertilization may be effected. A small number, *e. g.*, *Riccia fluitans*, *Riella*, *Fontinalis*, etc., are genuine aquatics, and the life history of such a form as *Ricciocarpus natans* illustrates what has probably been the origin of the terrestrial habit in the primitive archegoniates. *Ricciocarpus* is usually a floating plant, but it not infrequently assumes a terrestrial habit, sometimes preliminary to developing its reproductive organs. This is brought about by the subsidence of the water until the plant is left stranded on the bottom. Under such circumstances it grows very vigorously, develops numerous rhizoids which penetrate the mud and supply it with water. Excessive loss of water is checked by the development of a cutic-

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ularized epidermis covering the exposed surface of the thallus. It is highly probable that in some such way as this the algal ancestors of the first archegoniate plants began their life on land, and slowly emancipated themselves from the necessity of being surrounded by water, and of course thus became more and more independent of the drying up of the shallow bodies of water in which they grew. In this way the vegetative period would be much prolonged, and would give the plant a great advantage over its aquatic competitors, and thus the terrestrial habit was established.

Some liverworts and mosses may reach considerable size, a foot or more in length in a few cases. They also exhibit a certain amount of specialization, corresponding to the requirements of the terrestrial environment. Well-developed leaves are present in nearly all true mosses, and in many liverworts, and in one order of the latter, the Marchantiales, the plant body, while retaining its thallose character, develops a complicated assimilative tissue, with stomata of a peculiar type not found elsewhere. In the upright forms mechanical tissues are developed, and in the true mosses there is present in the leafy shoots a central strand of conducting tissue, comparable to the vascular bundles found in the sporophytes of the vascular plants. Indeed the analogies existing between the leafy moss-shoot and the sporophytic shoots of the vascular plants are sufficiently obvious.

No existing bryophytes have succeeded in reaching any but the most modest dimensions. All the larger forms either are prostrate or grow in dense tufts, offering mutual support to the leafy shoots. Indeed, no moss seems to have quite solved the problem of a self-supporting, upright leaf-bearing axis. Neither have they successfully solved the problem of an adequate water supply, to compensate for loss of water by transpiration, and this of course is closely associated with the limit of size which the plant-body can assume. Given an unlimited water supply, and a plant, even of low organization, may attain very large dimensions, as we see in the giant kelps. Those plants, although in many respects of very low rank, nevertheless may reach hundreds of feet in length, and develop

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specialized tissues, curiously suggesting those of the highly organized land plants. These giant seaweeds absorb water throughout their whole superficial area, and there is no loss of water by transpiration; but for a terrestrial plant to reach a large size there must be adequate means for absorbing water from the soil, and for transporting it expeditiously through the plant to those places where water is being lost through transpiration.

In the highest terrestrial plants, the "vascular" plants, we meet first with a perfect system of water-conducting tissue. This is the woody portion of the fibro-vascular bundles, composed of the characteristic tracheary tissue, first encountered in the ferns, and common to all the higher plants.

ORIGIN OF THE SPOROPHYTE.

Among the lower terrestrial plants, the Archegoniatæ, which comprise the mosses and ferns, a very marked characteristic is the "alternation of generations." By this is meant that in its development the plant passes through two very different phases, a sexual and a non-sexual one. This is perhaps best seen in the ferns. The spore of the fern, on germination, gives rise not to the leafy fern plant, but to a much simpler plant much like a small liverwort, upon which the sexual reproductive organs, the archegonium and antheridium, are borne. This sexual plant is known as the gametophyte. Within the archegonium is borne the egg-cell or ovum, which, after being fertilized, ultimately produces the leafy fern plant or "sporophyte," so-called from its producing the spores, or non-sexual reproductive bodies.

Among the lower Archegoniates, the gametophyte is relatively much more important, and the sporophyte is never an independent plant, as it is in the ferns, but always remains to a greater or less extent dependent upon the gametophyte for its existence.

An alternation of generations is hinted at among some of the green algæ, but never becomes sharply defined as it is in the archegoniates. Among the red algæ, however, it becomes clearly marked, and also in many fungi. In both of

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the latter cases it is extremely probable that we have to do merely with analogies, as there is not the slightest evidence of any genetic connection between either of these groups and the archegoniates.

With the green algæ, however, the case is somewhat different, and it is highly probable that the earliest archegoniates arose from some forms not very different from *Coleochæte*, a green alga in which the fertilized egg gives rise to a very simple sporophytic structure.

The increase in the output of the zygote, or fertilized egg, due to its division into a number of spores, instead of forming at once a single new individual, is an evident advantage which becomes increasingly important as the gametophyte assumes the character of a terrestrial plant, and the chances of fertilization, which requires the presence of water, become correspondingly lessened.

There are two theories as to the origin of the alternation of generations among the archegoniates, the "homologous" and "antithetic." The first holds that the non-sexual sporophyte is a direct modification of the gametophyte and probably arose from it as a vegetative outgrowth. The antithetic theory holds that the sporophyte always, in normal cases, arises from the fertilized ovum, and is a further development of the zygote which has arisen in response to the requirements of a terrestrial existence. There is not time here to consider at length the relative merits of these two theories. In a special paper before the Section, I hope to bring this matter up for discussion. For present purposes I shall assume that the latter (antithetic) view is the correct one.

As the ancestors of the archegoniates left their original aquatic habitat, the question of the water supply became of the first importance. All of these lower land plants have retained many of their original characteristics, among them the development of motile male cells (spermatozoids), which require free water in order that they may reach the egg-cell and fertilize it. That is, the plants are, to a certain extent, amphibious, and must return to the water in order that fertilization may be effected. It is very clear, then, that anything

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which tends to increase the number of spores resulting from the developed zygote will be advantageous, rendering a single fertilization more and more effective.

The alternation of sexual and non-sexual plants among the green algæ is not sharply marked, and has been shown to be largely a matter of nutrition. Nevertheless, as already mentioned, there is a hint of an alternation of generations in certain forms like the higher Confervoideæ. In these the germinating zygote produces a larger or smaller number of zoospores, which give rise to as many new individuals. From some such form as these in all probability the primitive archegoniates arose. As these became distinctly land plants, the motile zoospores resulting from the zygote of the algæ gave place to the non-motile spores characteristic of the terrestrial archegoniates; but of any transitional forms we are quite ignorant, and the gap between algæ and archegoniates is a very deep one.

The gradual specialization of the sporophyte exhibited by the existing liverworts and mosses is familiar to all botanists, and will only be briefly discussed here. Enough to say that from the simplest type, a globular mass of spores, with almost no sterile tissue developed, such as occurs in the Ricciaceæ, there are still found almost all intermediate conditions, culminating in the large and complex sporogonia of the true mosses, and the somewhat similar but much simpler one of *Anthoceros*.

In following such a series it is clear that spore-production, the sole function of the primitive sporophyte, becomes largely subordinated to its purely vegetative existence. Thus in such a moss as *Polytrichum*, the sporogenous tissue does not appear until a late period in the development of the sporophyte, and comprises but a very small fraction of its bulk. An elaborate system of assimilative tissue, with lacunar green tissue and stomata like those of the vascular plants, is developed, and the loss of water due to transpiration is made good by a strand of conducting tissue, which represents a simple type of vascular bundle.

While the elaborate sporophyte of the mosses offers certain suggestions of the structures of the vascular plants, it is much

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too highly specialized in other directions to make it in the least probable that it has given rise to any higher forms. The equally dependent, but much simpler sporophyte of the peculiar group of the Anthocerotales is probably very much more like the forms from which this independent sporophyte of the ferns arose, than is the more highly developed sporogonium of the true mosses.

The subject of the gradual elaboration of the sporophyte cannot be dismissed without reference to the very important work of Professor Bower, whose clear exposition of the progressive sterilization of the tissues of the originally exclusively sporogenous sporophyte is one of the most important contributions to the subject.

When we review the extraordinarily large number of resemblances between both gametophyte and sporophyte in the ferns and liverworts, the weight of evidence, to my mind, is overwhelmingly in favor of assuming a real genetic connection between the two groups. To say "that no structures among plants seem to have left so little trace of their origin as do the leafy sporophytes of Pteridophytes and Spermatophytes," is certainly to ignore all the principles of comparative morphology. When we reflect that the reproductive organs and mode of fertilization are the same in all archegoniates; that the early divisions and growth of the embryo are identical; that in the more specialized bryophyte the sporophyte develops assimilative and conductive tissues strictly comparable to those of the Pteridophytes; and finally, that the spore formation is identical to the minutest details; surely such a statement is very far indeed from stating the truth.

The fallacy of the arguments based upon apogamy has been ably refuted by Professor Bower. He has called attention to the fact that nearly all cases of apogamy are abnormal, and occur in forms where the sporophyte normally is produced from the egg. It is also noteworthy that the greater number of cases of apogamy occur in extremely variable species, such as the crested varieties of different ferns (*e. g.*, *Scolopendrium vulgare* var. *ramulosissimum*). Professor Bower has also called attention to the fact that these are all

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forms belonging to the highly specialized and relatively modern group of Leptosporangiatæ. If apogamy is a reversion to a primitive condition, it is strange that it should occur in the least primitive ferns, rather than in the older types.

I think we may fairly class the phenomena of apospory and apogamy with the numerous cases of adventitious growths so common among both pteridophytes and seed plants. In these the whole sporophyte may originate as a bud from any part of the plant. Such adventitious shoots may arise from leaves, as in many ferns, *Begonia*, *Bryophyllum*, etc.; from roots, in *Ophioglossum*, and many seed plants, *e. g.*, *Populus*, *Robinia*, *Anemone*, etc., or even from sporangia, as in the budding of the nucellus of the ovule recorded in several cases of polyembryony. Now, no morphologist would argue from these that they are in any sense reversions, and I cannot see why the case of apogamous, or aposporus budding is essentially different.

No bryophytes have quite emancipated themselves from the aquatic habit of their algal progenitors. While they may often dry up for an indefinite period without being killed, there is, nevertheless, much of the same dependence upon an ample water supply that we find in the algæ. Although much more resistant to loss of water through transpiration than are the few terrestrial algæ, nevertheless the bryophytes, as a rule, are much less suited to a genuine terrestrial habit than are the vascular plants. Much the same means are employed by many bryophytes, in the absorption of water, as by the algæ. Water may be absorbed by all the superficial cells, the roots playing a minor role as absorbents, except in those forms in which the plant is a prostrate thallus, where roots are often developed in great numbers. These delicate rhizoids, however, would be quite inadequate to supply the needs of a leafy stem of any but the most modest proportions. In a few bryophytes, *e. g.*, *Climacium*, there are rhizome-like modifications of the shoot, which may to a limited degree be compared to roots, but any proper roots, like those of the vascular plants, are quite absent. It would

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seem as if nature's attempts to adapt the originally strictly aquatic gametophyte to a radically different environment had been only partially successful, owing to the failure to develop an adequate root system to restore the water lost through transpiration. It may be that the range of variation any structural type may undergo is limited.

If we accept this hypothesis, it may help to explain the significance of the alternation of generations as developed among the archegoniates, and we can understand why the sporophyte has gradually replaced the gametophyte as the predominant phase of the plant's existence. Attention has already been directed to the perfectly well-known fact that sudden marked variations may appear in plants without any apparent cause. The work of De Vries emphasizes this, and refers all radical advances in structures to such mutations, which are clearly distinguished from the variations which occur within the limits of a species, but which cannot apparently overstep certain limits.

In accordance with this view it is quite conceivable that the first appearance of the leaf upon the sporophyte may have been comparatively sudden—that is, there may not necessarily have been a long series of preliminary structures leading up to a true leaf.

It has been urged that the antithetic theory of the nature of the sporophyte involves the sudden appearance of a new structure. The fallacy of this claim has been pointed out by Professor Bower, and a little thought will show that no claim is made of the sudden appearance of a new structure. While no strictly intermediate forms are known, there is certainly no difficulty in seeing the essential homology between the rudimentary sporophyte of such an alga as *Coleochæte* and that of Riccia. The antithetic theory merely claims that the structure developed from the zygote, which at first is devoted exclusively to spore formation, gradually develops vegetative tissue as well, and finally attains the status of an independent plant.

The highly organized sporophyte of the higher archegoniates is connected with the lower types by an almost con-

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tinuous series of existing forms, and through these with the still simpler structures found in the green algæ. The increased output of spores, with a corresponding number of new plants resulting from a single fertilization, is an obvious advantage, and undoubtedly is the explanation of the origin of the sporophyte.

If we compare the sporophyte of even the simplest liverwort with that of the algæ, there is noted an essential difference. The spores, instead of being motile zoospores, are non-motile, thick-walled structures, adapted to resist drying up—in short, the sporophyte is a structure essentially fitted for an aerial existence. Except in the very lowest types, there is developed a special massive absorbent organ, the foot, which is not unlike the root developed in the higher types, and is very different from the delicate rhizoids of the gametophyte. The latter always shows, to a greater or less degree, its aquatic origin.

From the time that the sporophyte has attained the dignity of an independent existence, its development proceeded on lines very different from those followed by the essentially aquatic gametophyte. As we have seen, the efforts of the latter to assume a terrestrial habit have met with only partial success, and it would appear that nature concluded to try again, taking as a starting point the essentially terrestrial sporophyte, which, as a fundamentally new development, seems to have proved more plastic than the gametophyte.

From the first, and this I believe to be highly significant, its water supply was obtained indirectly through the medium of a special organ, the foot. It is not important for a consideration of the question whether the foot, in all forms, is or is not homologous—enough that we find for the first time an organ sufficiently massive to supply all the water needed by the tissues of the developing sporophyte. The foot is a very different organ from the delicate rhizoids of the gametophyte, and much more like the true roots of the vascular plants, which, it is highly probable, arose as further modifications of the foot of the sporogonium of some bryophyte.

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With the massive root penetrating the earth and thus establishing communications with the water supply, the sporophyte becomes entirely independent. The possession of an apical meristem in the root allows of unlimited growth, and gradually the extensive root system of the higher plants has been evolved, keeping pace with the increase in size of the sporophyte, which, except with rare exceptions, obtains its whole water supply through the roots. Correlated with this increase in size of the sporophyte, has been developed the characteristic conducting tissues which constitute the vascular bundles. While rudimentary vascular bundles are found in the sporophyte of many mosses and in *Anthoceros*, the characteristic tracheary tissue, *par excellence*, the water-conducting tissue of the vascular plants, occurs only among the latter forms.

With the establishment of the sporophyte as an independent plant, the gametophyte serves mainly to develop the sexual reproductive organs from which the sporophyte arises. While the gametophyte among the lower pteridophytes is a relatively large and independent green plant, sometimes living for several years, it becomes much reduced in size among the more specialized heterosporous types, and may live but a few hours, as in species of *Marsilia*. In such forms little or no chlorophyll is developed by the gametophyte, which depends for its growth upon the materials stored up in the spore, or even lives parasitically upon the sporophyte, as in *Selaginella*, thus reversing the relation of sporophyte and gametophyte found in the lower archegoniates.

All of these modifications are in the direction of economy of water, in accord with the needs of a more and more pronounced terrestrial habit.

Just as heterospory arose independently in several groups of pteridophytes, so also the seed habit—the final triumph of the terrestrial sporophyte over the primitive aquatic conditions—developed more than once. The female gametophyte, included within the embryo-sac, develops without the presence of free water, and the germinating pollen-spore also absorbs the water it needs from the tissues of the pistil, through

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which the tube grows very much as a parasitic fungus would do. Except in a very few cases, the male cells of the seed plants have lost the cilia, the last trace of their aquatic origin, and are conveyed passively to the egg-cell by the growth of the pollen-tube.

Once firmly established as terrestrial organisms, and the problem of water supply solved, the further development of the seed plants is too familiar to need any special comment here. The great importance of water in affecting the structure of land plants is seen in the innumerable water-saving devices developed in the so-called "xerophilous" plants, seen in its most extreme phase in such desert plants as cacti, or in the numerous epiphytes, like many orchids and bromeliads.

In short, it is safe, I think, to assert that of all the extrinsic factors which have affected the structure of the plant body, the relation to the water supply holds the first place. The most momentous event in the development of the vegetable kingdom was the change from the primitive aquatic habit to the life on land which characterizes the predominant plants of the present.

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RANGE OF VARIATION IN *Eutypella glandulosa*. BY C. L. SHEAR.

ANTITHETIC *versus* HOMOLOGOUS ALTERNATION. BY D. H. CAMPBELL.

SPECIFIC DIFFERENCES IN THE WOOD OF ELM TREES. BY W. J. BEAL.

SOME UNDESCRIBED STRUCTURES IN *Synchytrium Decipiens*. BY F. L. STEVENS.

ON THE MANIPULATION OF SECTIONS OF LEAF CUTICLE. BY S. M. BAIN.

SUGGESTIONS RELATIVE TO BOTANICAL PERIODICALS AND CITATIONS. BY W. A. KELLERMAN.

ORIGIN OF THE PATAGONIAN FLORA. BY GEO. MACLOSKIE.

NUCLEAR AND CELL DIVISION IN *Diplophrys stercorea*. BY EDGAR W. OLIVE.

ON THE BEHAVIOR OF CERTAIN YEAST ORGANISMS IN PURE AND MIXED CULTURES. BY W. B. ALWOOD.

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THE DESERT BOTANICAL LABORATORY OF THE CARNEGIE INSTITUTION. BY D. T. MACDOUGAL.

THE PINES OF THE ISLE OF PINES. BY W. W. ROWLEE.

STUDIES IN ARACEÆ. BY D. H. CAMPBELL.

A PRELIMINARY SYNOPSIS OF THE NORTH AMERICAN SPECIES OF THE GENUS MITRULA. BY E. J. DURAND.

ON A FUNGOUS DISEASE OF THE MULBERRY FRUIT. BY W. A. ORTON.

NUMERICAL VARIATION IN PLANTS. BY J. B. NORTON.

CONTRASTS AND RESEMBLANCES BETWEEN THE SAND DUNE FLORAS OF CAPE COD AND LAKE MICHIGAN. BY HENRY C. COWLES.

THE PRODUCTION OF NEW VARIETIES OF ORANGES. BY HERBERT J. WEBBER AND W. T. SWINGLE.

ON THE FORMATION OF WART-LIKE INTUMESCENCES AS A RESULT OF SPRAYING WITH VARIOUS FUNGICIDES. BY HERMANN VON SCHRENK.

EVOLUTION NOT THE ORIGIN OF SPECIES. BY O. F. COOK.

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SOME EXPERIMENTS IN NUCLEAR AND CELL DIVISION. BY FRANK M. ANDREWS.

NEW EXAMPLES OF DIURNAL NUTATION. BY F. L. STEVENS.

PROBLEMATICAL FOSSILS SUPPOSED TO BE SEA WEEDS, FROM THE HUDSON GROUP. BY DAVID G. WHITE.

CULTURES OF THE LEAF-SPOT FUNGUS OF THE GRAPE. BY A. D. SELBY.

[The following papers were read before the Botanical Club of the Association and Section G, in joint session.

NOTE ON *Andropogon divaricatum* L. BY A. S. HITCHCOCK.

MUTUAL IRREGULARITIES IN OPPOSITE LEAVES. BY F. E. LLOYD.

NOTES ON CLASSIFICATION AND DISTRIBUTION OF EUPHORBIA. BY J. B. S. NORTON.

NOTES ON DIFFERENCES IN YIELD OF FIBER FROM *Agave rigida* IN YUCATAN. BY C. R. DODGE.

[The following papers were read before the Botanical Society of America and Section G, in joint session.]

PROBLEMS IN THE STUDY OF PLANT RUSTS. BY J. C. ARTHUR.

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THE DISTRIBUTION OF THE GENUS *Riella*, WITH DESCRIPTIONS OF NEW SPECIES FROM NORTH AMERICA AND THE CANARY ISLANDS. BY L. M. UNDERWOOD AND M. A. HOWE.

TYPES OF THE LINNÆAN GENERA OF FUNGI. BY F. S. EARLE.

PRESSURE AND FLOW OF SAP IN THE SUGAR MAPLE. BY L. R. JONES.

THE NUTRITION OF CERTAIN EDIBLE BASIDIOMYCETES. BY B. M DUGGAR.

ATAVISTIC VARIATIONS IN *Onagra cruciata* (NUTT) SMALL. BY H. DE VRIES.

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REGENERATION IN PLANTS. BY K. GOEBEL.

UREDINOUS INFECTION: SUGGESTIONS AND EXPERIMENTS. BY W. A. KELLERMAN.

CONTRIBUTION TO THE PHYSIOLOGY OF THE CELL. BY F. M. ANDREWS.

NORTH AMERICAN SPECIES OF THE GENUS *Mison*. BY W. A. MURRILL.

THE GENERA OF POLYPORACEÆ. BY W. A. MURRILL.

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CULTURES OF UREDINÆ IN 1902. BY J. C. ARTHUR.

HERBARIA ILLUSTRATING PLANT-FORMATIONS. BY F. E. CLEMENTS.

THE RELATIVE IMPORTANCE OF EDAPHIC AND CLIMATIC FACTORS IN DETERMINING THE VEGETATION OF MOUNTAINS, WITH ESPECIAL REFERENCE TO MT. KATAHDIN. BY H. C. COWLES.

TWO DISTINCT TYPES OF RIVERS FROM THE POINT OF VIEW OF PHYSIOGRAPHIC ECOLOGY. BY H. C. COWLES.

Podophyllum peltatum AS AN ANOMALOUS DICOTYLEDONOUS PLANT. BY D. M. MOTTIER.

THE FENESTRATION OF *Martensia*. BY C. MACMILLAN.

THE DEVELOPMENT OF THE EMBRYO-SAC IN THE GENERA OF THE SAURURACEÆ. BY D. S. JOHNSON.

THE ETIOLATION OF SEEDLINGS OF *Persea gratissima*. BY A. D. SELBY.

A FOSSIL PETAL OF *Magnolia* FROM THE DAKOTA GROUP OF KANSAS. BY ARTHUR HOLLICK.

ALKAVERDIN, A HITHERTO UNKNOWN PIGMENT, FOUND IN LEAVES OF *Sarracenia purpurea*. BY W. J. GIES.

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THE DIGESTIVE ACTION ENSUING IN THE PITCHERS OF *Sarracenia purpurea*. BY W. J. GIES.

SOME STUDIES IN FOREST ECOLOGY IN NORTHWESTERN MONTANA. BY H. N. WHITFORD.

THE CYTOLOGICAL BASIS OF THE MENDELIAN THEORY OF HYBRIDS. BY W. A. CANNON.

THE EFFECT OF WOUNDS ON TURGIDITY. BY H. M. RICHARDS.

THE PHYSIOLOGICAL ACTION OF HEAVY METALS IN MIXED SOLUTIONS. BY R. H. TRUE AND W. J. GIES.

WHAT IS A BUD, AND HOW LONG MAY IT SURVIVE? BY W. J. BEAL.

THE LIMITS OF ECOLOGY. BY F. E. CLEMENTS.

THE LIFE-HISTORY OF *Hypocrea alutacea*. BY G. F. ATKINSON.

THE ORIGIN OF THE ARCHEGONIUM. BY B. M. DAVIS.

STUDIES ON THE CYPERACEÆ. BY E. C. JEFFREY.

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Systematic Relations of the Genera of the Agaricaceæ By F. S. Earle.

A New Species of *Vincetoxicum* from Alabama. By A. M. Vail.

Notes on the Genus *Rouliniella*. By A. M. Vail.

Growth as Affected by Light and Darkness. By D. T. MacDougal.

Effect of Etiolation on the Cortex and Periderm of Trees. By D. T. MacDougal.

Aerial Propagative Roots of Globba. By D. T. MacDougal and W. A. Cannon.

Chemical Studies of Trade Varieties of Logwood. By B. C. Gruenberg and W. J. Gies.

Recent Botanical Explorations in Bolivia. By N. L. Britton.

Type Specimens of North American Species of Agrostis. By A. S. Hitchcock.

Applied Ecology. By B. E. Fernow.

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ANTHROPOLOGY.

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ADDRESS

BY

STEWART CULIN,

VICE-PRESIDENT AND CHAIRMAN OF SECTION H FOR 1902.

*AMERICA THE CRADLE OF ASIA.**

The idea that America is a new world, not only from the view-point of European discovery, but actually, so far as concerns its inhabitants and their civilization, is one that has been accepted almost without question. It is, indeed, a fundamental notion, having back of it all the impetus of religious sentiment and historic tradition. Almost from the period of discovery, learned writers have endeavored to confirm the theory of an Asiatic immigration, adducing the resemblance of the arts, religions, and symbolism, and the supposed identities of the language and physical types of the Indian with those of the inhabitants of Asia.

Preoccupied with the notion that America is the new world, they have seemingly lost sight of the fact that these resemblances offer quite as good proof of American intercourse with Asia as they do of an Asiatic invasion of our continent.

In a paper "On various supposed relations between the American and Asiatic races," read by the late Dr. Daniel G. Brinton, before the International Congress of Anthropology in 1893, after reviewing some of the more reckless statements which have been made as to the analogies between the Eskimoan and Ural-Altaic tongues, and as to the traditions of civilized people of America reporting that they came from Asia, he says: "But the inner stronghold of those who defended the Asiatic origin of Mexican and Central-American

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civilization is, I am well aware, defended by no such feeble outposts as these, but by a triple line of entrenchment, consisting respectively of the Mexican calendar, the game of Patolli, and the presence of Asiatic jade in America." In conclusion, he declares that "up to the present time there has not been shown a single dialect, not an art or an institution, not a myth or religious rite, not a domesticated plant or animal, not a tool, weapon, game, or symbol, in use in America at the time of the discovery, which had been previously imported from Asia, or from any other continent of the old world."

I have quoted the above extract at length as a comprehensive expression of the opinion to which the more considerable part of the students of American antiquities have come at last. Without all going as far as Dr. Brinton in claiming absolutely that the American culture must have sprung from the soil of this continent, the more serious have abandoned the search for Babylonian, Egyptian, or Chinese influences underlying the ancient civilization of America as profitless and vain.

At the same time there remain to be explained the curious and bewildering similarities between the culture of the two continents. Many of them may be referred to the universal sameness of man's physical and intellectual necessities; and others, more intricate, may be dismissed by the aid of some such theory of psychological identity as was found convenient by Dr. Brinton. But there are other parallels which even the most devoted advocate of the theory of independent origin cannot ignore—parallels which cause one who rejected the Asiatic theory of American origins to exclaim that "man is what he is, in spite of, rather than on account of, his environment."

We find upon the Western continent things not only similar to those of Asia, but precisely identical with them; things not only the same in form and use, but in source and development as well, and at the same time so empirical and complex that no theory of their having been produced independently under like conditions, of their being the products

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of a similar yet independent creative impulse, seems longer tenable.

If we reject the theory of Asiatic origin, there are two explanations open to us: First, that at one period of man's history he had certain ideas in common on both continents; that his customs were fundamentally the same and knew no geographical boundaries. Second, that these identical customs originated in America, and were disseminated thence over the world; that the American culture, no longer to be regarded as sterile and unproductive, must be given its due place among the influences which have contributed to the origin and development of our own civilization.

In supporting the latter view the writer is aware that it premises the same, if not a higher, antiquity for man on the American continent as is revealed by the most remote historical perspective of Egypt or Babylon; that he is called upon to establish the American origin of the particular things to which he refers, their birth and subsequent development in America, and furthermore to demonstrate the probability of their transfer from America to other civilizations.

Let us turn to what is reputed to be the oldest surviving book in Chinese literature, the Yi King or "Book of Changes," a work which the Chinese revere as dating from the twelfth century B. C. This curious volume is a treatise on fortune-telling or divination, and consists of sixty-four magical diagrams, under each of which are oracular explanations. The appendices to the work are attributed to Confucius. In the practical employment of the Yi in fortune-telling, fifty slender polished wood or ivory rods are manipulated between the fingers and divided at random into two bundles, one of which is then counted off in twos around an eight-figured diagram. A series of determinations are made in this way, which are finally referred to one of the sixty-four diagrams of the Book of Divination, and the forecast gleaned from its explanatory text. The process is described at length in the third appendix. Divination with these splints is widely practised at the present day by the literary class in China, Korea, and Japan. A scholarly treatise on the subject was

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printed in Tokyo in 1893, and one may still see the fortune-teller with his bundle of splints at the street corners in Japanese cities.

Now the splints used in Asia find their exact counterpart in America in the gambling-sticks used by many tribes. Thus in Hupa Valley, California, we find the same bundle of fine rods, manipulated in the same way by rolling in the hands, divided at random into two bundles, and counted off as in Asia, the only difference being that in America, instead of divination, we have a game in which another player guesses which of the two bundles contains either the odd or a specially marked stick. Even the number of the sticks remains practically the same. This stick-counting was the celebrated game of "Straw, or Indian Cards," which the early writers described among the Hurons. It extended and is still found among tribes from the Pacific to the Atlantic coast. Educated Japanese have frequently expressed admiration to the writer at the beauty and suitability of the American implements for their beloved Yeki. Lawson tells us that in North Carolina a good set of the gambling-reeds were considered as equivalent in value to a dressed doeskin.

In Asia we have the custom with its literary traditions, but with no suggestions or explanation as to the origin of the bundle of splints. In China, we read, the stalks of a plant —the *Ptarmica siberica*—were anciently used, those which grew on the grave of Confucius being most highly esteemed In America it becomes apparent that the splints are merely other forms of the large gambling-rods, such as are found on the Pacific coast—rods which with their bands or ribbons of color may be referred to the similarly marked shaftments of arrows, from which they are clearly derived.

In America the arrow seems to have been the chosen symbol of the warrior, of the man. Among the Dakota we have a description of the making of painted sticks, each marked for a warrior, and their subsequent use in gambling. The game of "Straw" among the Huron was rightly designated "Indian Cards" because their gambling-sticks not only correspond in a way to our cards, but give us a veritable

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clue to the ancestry of cards themselves. The Korean cards are nothing more than long slips of oiled paper, each bearing on its back the picture of a feather, and designated by a name meaning "arrow," the play being called "Fighting Arrows." On their faces are rude scrawls, numerals from one to nine, and suit-marks totemic animals, which, according to their traditions, were actually figured upon their original bamboo cards. In America the arrow-derived ribboned gambling-sticks of the Pacific coast are divided into similar animal suits, and some of the sets are actually engraved with animal figures. It is clear that the American sticks serve to explain the derivation of the Korean cards. But that is not all. The narrow playing cards (money cards) of China, with their suits of nine cards each, frequently bear the old notches as numeral and suit-marks at the ends, and are clearly the legitimate descendants of the arrow-derived gambling-sticks. Their suit-marks became money denominations—with pictures of coin derived from old bank-notes, and grotesque figures taken from the illustrations of a popular novel. And when the cards were made broader, they were so suggestive of the designs on the old Spanish packs as to furnish the best available explanation of the source of European cards, the origin of which has hitherto been obscure.

Leaving the subject of games for a moment, let us contemplate this use of the arrow as the symbol and emblem of man. It is one of those universal things in America from which we cannot escape. The baho, or prayer-sticks, of Indian ceremonial appear, from archaic forms, to have been originally arrows. A conventionalized arrow is used to-day in China as the man-representing counter in the game of "Chief of the Literati," and as the notice-tablet of the merchant's guild hall. The paper visiting card of eastern Asia appears to have had the same line of descent. The Korean arrows for ceremonial archery bear their owner's name written upon the shaftment. The carved arrow-derived gambling-sticks of the Pacific coast, taken in connection with the cylindrical pottery-stamps of farther south, not unlikely of kindred origin, furnish us with a clue to the explanation of that

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interesting symbol of authority in Asia, the seal cylinder of ancient Babylonia. Without dwelling upon the evidence afforded in the early Babylonian writing, it is sufficient to say that the suggestion has received the approbation of the distinguished scholar Dr. Herman V. Hilprecht. Penetrate to the lowest strata of the historical remains of Asia and we come to conditions approaching those which survive among the living tribes of our own continent.

It is not my object here to emphasize the importance of the study of the American culture, and I return again to one of the most striking and interesting identities that have been observed in the two continents in the domain with which I am most familiar. I am constrained to speak no longer of parallels and similarities, but of identities. One of the universal games among the Indians of North America is played with four or more two-faced sticks which are used as dice, the counts being kept upon a circuit, which varies from a simple circle of stones to a cross-shaped diagram, as in old Mexico. Comparison of the sticks, and of the many other objects substituted for them, shows that they were originally split cane arrows. The game, played with actual split arrows, survives among the Indians of Zuñi. We find this game in Korea played in the same manner, with the same kind of sticks, and counted around a circuit, like that used by the Indians. In old Mexico marked beans were employed as dice, as among the Cherokee to-day, and the game was known as Patolli, being none other than one of the triple line of entrenchment which Dr. Brinton ascribes to those who defend the Asiatic origin of Mexican and Central-American civilization.

Dr. E. B. Taylor first called attention to the striking resemblance of Patolli and the Hindu game played with cowrie-shells, called from its count Pachisi, or "twenty-five." The similarity is here not in the dice, but in the board, the Hindu and Mexican cross-shaped circuits agreeing so closely that an independent origin seems impossible. After a careful examination of all the forms of the American game it is apparent to the present writer that we have in the native culture all

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contributory and formative elements that led to its invention and development. It is, like all the American games, so clearly the outgrowth of native rituals and ceremonies, so identified and bound up with them, that we have no reason to believe it was borrowed directly from Asia—the Asiatic forms, of which there are many, all existing along lines representing a development from, rather than toward, America. If the relation be that of parent and child, the parent, it would seem, is here. Hence the fallacy of looking for traces of Eastern civilizations upon our continent.

It is a well-known fact that in the struggle for existence the oldest types are often found surviving at places most remote from their origin, but we have too many evidences of the orderly development of this game in America to regard it as the case in point.

Let us glance at another of the Indian games, played, like the stick-dice, by all our tribes—not, like it, a game of chance, but of dexterity. It consists in throwing darts at a rolling hoop or wheel, the counts depending upon the position in which the missiles fall with reference to the hoop. It is commonly known as Hoop and Pole. The hoops or rings are of the greatest variety of form and material, some even being made of stone, but all may be traced to a netted hoop, simulating a spider-web, the game being bound up with ceremonies connected with generation and fertility. The webbed hoop leads back to the Spider Goddess, the Earth Mother, and was formerly used among the Pawnee to secure plenty of buffaloes. Among the Wasco on the Columbia it is played with a ring of bast to secure a good run of salmon. It occurs among the Ainu in Japan, where John Batchelor describes it, in a simple form, as an amusement of boys, and says it appears to have been invented to teach children to spear salmon in the river.

This netted spider-web hoop gave rise in America to another simple game of dexterity, analogous to cup and ball. From the netted hoop caught on a dart or pin we find a great variety of derived forms, all leading back to the same source, and many of them suggesting the original idea of the spider-web

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of the Spider Mother in their very common name of the "match-making" or "matrimonial" game. These are no importations of the familiar bilboquet into America. On the other hand, they illustrate the possibly remote and complex origin of what is now a simple toy. The same spider-web is used by the Indians to explain the cat's-cradle, of which they have countless forms. The Zuñi say it was taught by their grandmother the Spider to the Twin War Gods, her grandsons.

The writer has undertaken the minute and systematic examination of those fragments of ancient rituals which, in accordance with common usage, we designate as games. After a comprehensive examination of all the games of the American tribes, it appears to him that they may be classified in some four or five interdependent and related groups, in which the implements employed show progressive modification of form, suggesting a common source in specific ceremonies, as well as a geographic centre in America from which they probably emanated. The ceremonies were divinatory, and this divination I would explain as an "experimental sacrifice." Tentatively I would assign the geographical centre to the arid region of the Southwest, rather than to Mexico and the higher civilizations of Central America.

The games of the Eastern continent—and I speak now not so much of the present day, but from what we know of the remote past—are not only similar to, but practically identical with, those of America, and are not only alike in externals, but, if we may so apply the word, in their morphology as well. And, it may be added, they extend over into Asia from America as expressions of the same underlying culture. They belong to the *same* culture.

Man evidently wandered far and wide over the world before history began. Shall we, with our American explanations in mind,—and they hold good not alone for games, which are but the "stalking-horse" of the student,—shall we not assent to the claim that ancient America may have contributed to an extent usually unimagined, her share of what is now the world's civilization?

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Pawnee Star Lore By Miss Alice C. Fletcher.

Recent Investigations Among the Pawnee. By George A. Dorsey.

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The Tube-Guessing Game of the American Indians. By Stewart Culin.

Algonquin Names of Mountains and Hills. By W. W. Tooker.

Tribal and Social Organization of the Indians of California By A. L. Kroeber.

The Extinction of the Pecos Indians. By E. L. Hewett.

Sheet Copper from the Mounds is not Necessarily of European Origin. By Clarence B. Moore.

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CARVED HUMAN BONES FROM THE HOPEWELL GROUP. BY GEORGE A. DORSEY.

THE EXCAVATIONS OF THE GARTNER MOUNDS. BY WM. C. MILLS.

THE FOSSIL HUMAN REMAINS FOUND NEAR LANSING, KANSAS. BY WM. H. HOLMES.

INCRUSTED CRANIA FROM CAVES IN CALAVERAS COUNTY, CAL. BY WM. H. HOLMES.

[The following papers were read before the American Anthropological Association and Section H, in joint session.]

THE INTERNATIONAL ARCHÆOLOGICAL AND ETHNOLOGICAL COMMISSION. BY W J McGEE.

CONVENTIONALISM IN AMERICAN ART. BY FRANZ BOAS.

ECONOMIC ANTHROPOLOGY. BY L. M. KEASBEY.

ANTHROPOMETRY; ITS RELATIONS TO CRIMINOLOGY. BY E. LINDSEY.

GRAPHICAL METHODS IN ANTHROPOMETRY. BY FRANZ BOAS.

SOME PRACTICAL PROBLEMS FOR THE CONSIDERATION OF AMERICAN ANTHROPOLOGISTS BY FRANK RUSSELL.

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ORIGIN OF SURNAMES. BY ANITA NEWCOMB MCGEE.

THE GRAMOPHONE METHOD IN COLLECTING DIALECTS. BY E. W. SCRIPTURE.

THE MODERN PEQUOT LANGUAGE AND PEOPLE. BY J. D. PRINCE AND F. G. SPECK.

A STUDY OF SPINDLE WHORLS FROM MEXICO TO COLOMBIA. BY MISS H. N. WARDLE.

THE CULTURAL DIFFERENTIATION OF THE MAIDU. BY ROLAND B. DIXON.

[The following papers were read before the American Folk-Lore Society and Section H, in joint session.]

THE RELIGION OF THE ARAPAHO AS DETERMINED BY THE RITES OF PRAYER AND FASTING. BY GEORGE A. DORSEY.

BOAT-BURIAL AND THE MAGIC SHIP IN MEDIÆVAL ROMANCES. BY W. W. NEWELL.

MYTHS OF GESTATION AND PARTURITION. BY WASHINGTON MATTHEWS.

THE MYTHOLOGY OF THE YUROK. BY A. L. KROEBER.

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HAIDA MYTHOLOGY. BY J. R. SWANTON.

SYSTEM AND SEQUENCE IN MAIDU MYTHOLOGY. BY ROLAND B. DIXON.

INDIAN ARROW POISON. BY W J McGEE.

THE ALEUT AND HIS FOLK-LORE. BY F. A. GOLDER.

CERTAIN MARYLAND SURVIVALS. BY MISS A. W. WHITNEY.

THE THEFT OF SUMMER—A CROW LEGEND. BY S. C. SIMMS.

THE INFLUENCE OF THE ALGONQUIN LANGUAGE ON ENGLISH SPEECH IN AMERICA. BY ALEXANDER F. CHAMBERLAIN.

A LEGEND OF THE HURONS. BY ROBT. BELL

A LEGEND OF THE WABINIKI. BY ROBT BELL.

A LEGEND OF THE MONTAGNAIS BY ROBT. BELL.

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[The following papers were read before the American Anthropological Association, the American Folk-Lore Society and Section H, in joint session.]

THE CANYON DE CHELLY. BY P. W. JONES.

PIMA ANNALS. BY FRANK RUSSELL.

PROGRESS IN ANTHROPOLOGY AT PEABODY MUSEUM, YALE UNIVERSITY. BY GEORGE GRANT MCCURDY.

GEOLOGIC CHRONOLOGY OF THE AMERICAN RACE. BY W. H. HOLMES.

AN OJIBWA CEREMONIAL. BY D. I. BUSHNELL, JR.

COMPARATIVE STUDY OF MORTUARY POTTERY FROM PAJARITO PARK AND TEWA. BY E. L. HEWETT.

THE INTRODUCTION OF THE BANANA INTO PREHISTORIC AMERICA. BY O. F. COOK.

NEGRO BURIAL CEREMONIES AND SOCIETIES. BY ROLAND STEINER.

NAHUATT HOUSE TYPES. BY R. T. HILL.

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SECTION I.

Social and Economic Science.

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ADDRESS

BY

CARROLL D. WRIGHT,

VICE-PRESIDENT AND CHAIRMAN OF SECTION I FOR 1902.

THE PSYCHOLOGY OF THE LABOR QUESTION.

Sir William Hamilton defines psychology as the science conversant about the phenomena of the mind, or conscious subject, or self. It is also the science of the human soul—the systematic or scientific knowledge of the powers and functions of the human soul. It comprehends a vast body of facts and a vaster body of theories. Its theories are infinite, like hope; its facts are infinitesimal, like knowledge. Yet, through metaphysical reasoning and the application of the known elements, the advance in psychology has been great indeed, and its adjustment to human affairs most beneficent.

The labor question cannot be defined so easily or so concretely, yet any definition which leaves out the conscious subject or self, or ignores the systematic or scientific knowledge of the powers of the human soul, falls far short of a due comprehension of the questions of labor. The labor question in a narrow sense is one thing; in a broader sense, quite another. It is very much a matter of approach—of how you look at it. To the union seeking an advance in wages, wages constitutes the labor question; or, to the union seeking reduction in the hours of labor, lessening the time of toil is the labor question; and so it is, from an individual point of view, a many-sided problem, each individual feeling that his view of it comprehends the whole of it.

The labor question, in a broad sense and on a philosophical basis, is a very different matter. It comprehends nearly

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all of the attributes of human nature; it comprehends the struggle of the human race for a better and a higher standard of living. It is, concretely, the restless hope of mankind, and it springs from the restlessness which God implanted in the human race and which is the primal cause of all advancement.

Formerly workingmen made the demand for what we understand as a wage rate sufficient to keep body and soul together—just enough compensation for labor expended to keep the human machine properly lubricated—and this gauge of the wages of labor was known as the iron law of wages. To-day the demand of labor comprehends something more than this; it is a demand for what we may term, for convenience sake, the spiritualizing influences of the time. I do not use this word in any pietistic sense, but in the sense comprehending those things outside physical wants—education, art, music, leisure—everything that makes a man better, everything that builds him up and raises him to a higher scale of civilization. The æsthetic potentialities of life are what the workingman is demanding to-day, and he is demanding the opportunity for a better life through higher wages and a lessening of the hours of labor.

This present-day question is only an advance of the old-time labor question, which began with the Aryan and his race encircling the earth. Restlessness drove him to it. He founded cities, he built nations, he crossed oceans, he discovered and peopled continents, but it was the inborn, divine restlessness implanted in him that drove him around the earth; and this restlessness of the Aryan epitomizes the labor question. In it there have been varied phases, a multiplicity of questions, one running into the other, and so complicated as a whole that it has been impossible almost to differentiate and select any one phase of it and say, with this solved, with this problem removed, peace and prosperity and harmony would obtain everywhere.

In this struggle and in this epitomized labor question there have been a great deal of suffering, many incongruities and hardships, and these in turn have grown up not only as

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the result of the conditions prevailing but as the result of belief. The power of belief results in action. If a man believes that he is being wronged it is nearly the same with him as if he were actually being wronged. His action is taken on his belief with just as much assurance on his part as if his belief were crystallized into fact. This may be the result of heredity; it may be the result of birth into a position, where a man feels held and bound to follow the occupation of his ancestors; or he may be so dulled by his birth into position, by his heredity, that he goes through life filled with apprehension, filled with a belief which he cannot overcome, that there is nothing better in life for him.

The power of apprehension in industrial matters is best illustrated by its influence in producing and sustaining industrial depressions—prolonging them. There is a suspicion, a rumor, of insolvency, of unsoundness, which results in action, and that action produces the depression; and the depression, which may follow a financial crisis, is mental; it is a disease as much as it is an effect of some industrial cause. We have seen that demonstrated a great many times. The psychology of this particular phase has been illustrated in Dr. Edward D. Jones' valuable work entitled "Economic Crises," in which he has a chapter on The Psychology of Crises. Dr. Jones remarks: "As this science (political economy) treats of a portion of the social activity of man, it must receive as a part of its premises the statement of the psychologist regarding the individual and social psychology of man and apply it in the explanation of economic society."

The suspicion of the soundness of a bank creates a run upon it. The suspicion of the soundness of a business house destroys its credit, and while over-extended credit may be the immediate cause of financial crises, resulting in industrial depressions, that apprehensiveness which preceded all is the underlying, psychological cause of them. We remember the Frenchman who, on presenting his check at the bank (which he supposed could not pay) and finding that the cashier could pay it, said instantly: "If you can pay, I do not want the

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money; if you cannot pay it, I want it immediately." That illustrates the psychological aspect in a whole community relative to business enterprises and banking generally.

Yves Guyot has expressed himself strongly on this point in his statement, similar to that of Dr. Jones', that "In economy as in all other social phenomena, psychological facts play an important part. It is because they have not been sufficiently taken into account that we have had so many erroneous explanations of commercial crises." And our own writer, Horace White, has testified that "the want of confidence which upsets commercial calculations and brings on a crisis, is the disturbance or rupture of a commonly received notion that 50 cents worth of goods are equal to a dollar in gold." It is the play of the power of imagination on material things.

The writers I have quoted have touched emphatically upon a great truth. In my own study, some eighteen years ago, of industrial depressions I found that the alleged causes for such occurrences were quite as numerous as the number of men who alleged them, and that while it might be safely considered that undue or over-extended credit—speculation—was the immediate cause of a financial crisis and a subsequent industrial depression, apprehension, or the power of belief upon action was the real, underlying psychological element, which carried industrial depressions to such disastrous results. This is evidenced by the fact that the margin of production during a period of depression and a period of prosperity does not vary more than 6 or 8 per cent., and that employment varies in like proportion.

The statements of the writers to whom I have referred, relative to industrial depressions, bear most distinctly upon the labor question, as labor suffers more in degree during depressions than does capital and is far more apprehensive so far as personal wants are concerned.

The power of belief upon action is well illustrated where the opportunity for injustice exists. This opportunity leads to the belief that injustice does exist; hence the suspicious attitude of labor and capital. This is well demonstrated in the opportunity for injustice in the prevailing methods

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of paying for coal as it is mined. Coal is paid for generally either by the car-load or by the ton, and the car-load of coal is subjected to a docking system in order to offset the impurities which are mined with the coal. The miner does not complain of the deduction for impurities, but he does complain of the proportion of docking which is assessed against him. This clearly illustrates the thought which underlies my statements. Even if the docking is absolutely just and accurate in every respect the opportunity for injustice exists, and the miner becomes suspicious. He feels that he is being unjustly dealt with and is irritated and annoyed, and he undertakes on his part to offset the docking system by cribbing; that is to say, he will build up his car with large pieces of coal, putting them in the car in a slanting position or bridging them over, and then put the loose coal on top, whereby he thinks he overcomes the injustice of the docking boss. Now, the employer is just as suspicious of the cribbing as the employee is of the docking. It is a psychological question clearly and entirely.

So, in regard to what we now understand in political economy as, perhaps, one of the most serious questions in it—economic insecurity; that is, the insecurity which comes from the lack of power to accumulate sufficient means to carry a man and his family through life after he is incapacitated for work. This has an exceedingly deep-seated effect upon the workingman. It is a result of industrial conditions, and sooner or later it must be overcome; but it causes an anxiety as to years of decadence and lack of capacity which really interferes with the efficiency of the man before that period is reached. It is a psychological question.

On the other hand, the actions of workingmen, when suggestions are made for the betterment of their condition, excite a psychological power. I have known many employers who have suggested profit-sharing, or some other form of extra remuneration, to meet with decided opposition on the part of the employees because of the suspicion which lurked underneath it all, and they have rejected such beneficent proposals simply because they believed they were made

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for the purpose of exploiting them to a still greater extent than under the wage system.

There have been some very recent striking illustrations of this suspicion, when efforts have been made to give wage-workers some share of the profits of production. I need not cite all these illustrations, but two of them will be used, for they carry with them very distinct lessons. One relates to an employer who is hard in many ways and harsh in the management of his works, yet he had the disposition to employ philanthropic methods in improving the condition of his employees and making their lot somewhat more endurable. To carry out this idea he established a club-house and also organized a corps of trained nurses, whose services, when employees were ill or suffering from accident, were to be free. Instead of accepting the services of the nurses, they were looked upon by the employees as spies of the employer, sent purposely into their homes in order to learn conditions relative to food and general living; and thus the effort, instead of being beneficent, as it was intended to be, became a source of great irritation and trouble.

In another prominent case, where the employing company introduced many methods whereby a better condition was secured, or at least intended, the men became suspicious of the motives which prompted them and insisted that they were instituted simply and solely for the purpose of preventing any organization of the laborers employed. This attitude became so pronounced that finally there was a strike in the works, and now, although this concern has carried the question of betterment to greater extent than perhaps any other establishment in the country, it is boycotted and freely advertised in labor papers as unfair.

There is the psychology of the boycott and the blacklist. The boycott and the blacklist are the same thing, only originating in opposite directions. The boycott is the weapon of the workingman; the blacklist, of the employer; and whether the boycott or the blacklist really exists, there is the suspicion left on the part of the two elements of production that they are to be found and that they are effective

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in their operation. These must do for illustrations of what I mean.

I have tried to solve by the statistical method some of these questions where the psychological elements were concerned, but I have found the statistical method inadequate in almost every direction. In many directions it is impossible to ascertain, by the statistical method, the motive for an action, although it may be possible to record the action and a million kindred actions which result in a statistical conclusion. Take the statistics of strikes. It is easily ascertained how many strikes have occurred in a year, in what industries they have prevailed, the losses of the employers and of the employees, the duration of the strikes, and all that; and yet with all this array of statistical tables we have not touched the motive underlying the strikes themselves—we have not reached the psychological power which brings the strike into existence, the inborn hope for better conditions.

Another illustration, however, proves the reverse, and the statistical method becomes adequate. This was well shown in the Eleventh Census, in the statistics of mortgage indebtedness. There the causes of indebtedness were given, and between 94 and 95 per cent. of the mortgages recorded were to secure helpful results. They were not the results of misfortune; they were for the purpose of extending domain, increasing a plant, educating a son, or in some way improving the original property, thus showing, as most of us know through observation, that a mortgage on real estate is usually an evidence of prosperity and not of misfortune. The other 5 or 5½ per cent., and that only, represented the causes which could be attributed to some form of misfortune.

It must not be understood, when I say that a mortgage on real estate is an evidence of prosperity and not of misfortune, that I consider debt a blessing, for debt, in the ordinary conception, is a hindrance to progress and a burden to the man who incurs it; yet debt incurred in some ways means something else. For instance, a man having one hundred thousand dollars' worth of property wishes to

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engage in some business, and in order to do so he raises a loan of fifty thousand dollars on his property and invests it in some active undertaking. Is this debt an evidence of misfortune, or is it even a burden?

In another case a wage-earner is able by his savings to secure a small lot of land, and, having paid for that, through a building and loan association or a savings bank, or through the kindness of a friend, he borrows money enough to erect a little cottage. He then becomes an interest payer instead of a rent payer, but by his savings from year to year he reduces his rent, which he is paying in the form of interest, until finally he owns the property free and clear, and he has no more rent and no more interest to pay. Is such a debt a burden, or is it a blessing? Is it an evidence of prosperity or of misfortune?

Writers argue that property is to be secured only through rigid economy—saving. Very well. Is there any better way than through the illustrations given? There is the prospect of making the savings efficient, and the securing of a home becomes the aim and the ambition of the family. Was the man who built his little cottage any worse off after having put a mortgage on his land than before? Was he suffering under a burden of debt which handicapped him and made his life miserable? Wherever debt is incurred as the result of unfortunate conditions, of extravagance or recklessness, then it is a burden to be deplored; but in all cases one sees the psychological result proved by the motive, and in the statistical presentation cited the motive was shown by the statistics themselves.

Thirty years ago I thought the labor question a concrete matter that might be solved, but whenever I have thought I was approaching a solution I have become more and more impressed with the fact that it is the problem of the human race in seeking better and higher conditions of life; so that now, whenever a solution is suggested to me, I feel as I do when I take up a strange volume of statistics. The distrust which comes from the suggestion of a solution and that which comes from the examination of a volume of

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statistics, when I do not know who made it or how it was made, are precisely the same, and they cause me to study deeper and ascertain the methods and processes employed and the character of the man whose name is on the title page of the statistical volume and the experience and knowledge of the man who suggests a solution for the labor problem. So that I have not that interest now in solutions which I used to have, and I do not feel that a solution can come, because of the infinite ramifications of the whole matter.

I do not wish to be misunderstood in this matter. It is true that the conditions which surround industry at any one time, and which constitute for that time the labor question, may, and can, and ought to be removed, in so far as they are unhappy, uneconomic, or disquieting; and so the solution of the labor question becomes a progressive matter. When we have removed the incongruous or unhappy conditions of one time we find ourselves in other conditions, with an increased intelligence surrounding them which makes them as important and as irritating as those which existed at a prior time and which have been removed. If the labor question, therefore, be a progressive one, if it be epitomized in the struggle of humanity to secure a better and higher standard of living, then it cannot be solved on any permanent basis, for each solution opens other questions of a higher nature than the previous ones. This is an evolution of human conditions, and the conditions which each age brings constitute for that age the labor question; they are the results of the hope and aspiration of humanity to secure better environment.

Whenever one says that there is no solution for the labor problem except through growth, through intelligence, through education, through a better understanding of all the motives which underlie conditions, he is usually called a pessimist, or a man without hope, because he does not see that some of the isms of the day are ample to secure full and complete changes. Being an optimist, I cannot accept this view.

We may solve the sweating system; the introduction of the factory has solved it except in one industry. Prior to the inauguration of the factory system sweating was general;

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now it is concentrated upon one or two industries. The extension of the factory system will solve the problem so far as that particular phase of it is concerned; but will it solve the labor question as a whole? Can the labor question, as a whole, be solved when each age brings new conditions? This is what I mean when I say I have no faith in proposed solutions of the labor question. They are temporary; they may help to remove a single bad condition; they may help bring about an improvement in some one or more directions.

It is just like the question of crime and social disorder. The more sensitive we become, through increased knowledge, through altruistic feelings, through a desire to help in every direction those who are struggling, the more clearly we see and the more thoroughly we feel the irritation of things which, with less intelligence, with less knowledge, would have but little effect upon us. A community of criminals would not recognize crime, or, if it did, would not institute any measures for its repression or punishment; but an enlightened community, one that has grown out of the crude conditions of the past, recognizes moral obliquity and is constantly providing means for its repression. This statement applies to the labor question, and it involves far-reaching psychological study.

Once little girls working all night long would not have excited any great amount of interest. To-day the public conscience condemns such things, because it is more keenly alive to unhappy conditions and more sensitive to all violations of the moral law than at any other time in the history of the world. Hence there crowd upon us questions, both social and industrial, that would not have been recognized without the sensitive conscience that now exists.

It is the duty of governments, as well as of individuals, to undertake to comprehend the labor question on the broadest philosophical plane and to do everything that can be done, both economically and ethically, to remove the opportunities for injustice, to establish better methods, to secure to workers an increased proportion of the profits of industry, and to insist that society, which is prosperous only when industry is prosperous, shall in some rational way bear the burdens of the

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men who make industry what it is. If it be necessary for the well-being of society that men in industry or groups of industry must risk their lives and imperil their health, then society, through consumption, should guarantee to such men a return which will protect them from economic insecurity, which has such a deteriorating effect upon the minds of the men engaged.

It is not enough to say that because physical or chemical questions have been solved, there is a solution for every moral and industrial question. Great explorers have acted upon theories, as did Columbus, and men who said that Columbus was a foolish man were acting on their ignorance, even though Columbus was acting on a theory only partially developed. So when steam was applied to ocean navigation, and a steamboat was constructed in Liverpool for the purpose of crossing the Atlantic, it was felt that even though the boat might make a start, it could never land; and on the evening of its arrival in America a distinguished physicist, giving a lecture in the city of Philadelphia, stated that the world would never hear of the steamboat which was to have left Liverpool on a certain day, because it was a physical impossibility to propel the boat across the Atlantic by steam power; but on the morning after the lecture the newsboys were crying the boat's arrival.

Such illustrations do not belong to a progressive question like that of capital and labor, involving the relations of employer and employee. The labor question reaches deeper than any question of physics or that of any other realm of material adjustments. Inventive genius is one thing; the psychological attributes of the human mind another. So in studying this question we are always confronted, not with material obstacles, not with mathematical problems, not with what appears to be physical impossibilities, but with a wall of human elements—ignorance, skill, capacity, incapacity—which affects the economic consideration of the question; and with a wall of human attributes—want or desire, frugality, prodigality, hope, love, cupidity, envy, pride, temperament—which affects the ethical consideration of the question. We may be able to settle phases of the labor

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question under economic laws, but the results are not satisfactory or complete; or we may be able to settle phases under ethical laws, but the results are not satisfactory or complete: we must combine all these with psychological phenomena.

The great question is therefore to be treated by one perfectly competent and thoroughly equipped in economics, in ethics, and in psychology. It needs that metaphysical reasoning, study, and analysis which only such equipment can bring to it. It is not in my power to carry this question through to its logical conclusions; I have not the equipment. It should be done by some man who is familiar with psychological laws and the various phases of the labor question as well. I have simply hoped to suggest this line of work to some competent man.

It has been attempted in a brief way, for a few years ago, while the psychology of the labor question was interesting me, Mr. Wallace, of England, brought out an article in the Fortnightly for November, 1893, entitled "The Psychology of Labor and Capital," in which he used the following language: "Labor, however, must beware of killing the layer of the golden eggs. Labor may attempt to pass the point where its own strength and capital's patience break down, and an encounter ensue, in which it will have the worst. Ethically, labor seems a higher thing than capital, because the essence of it is to transfer an idea from itself to nature and enrich it by the incorporation of a human conception, while capital merely covets nature to enrich itself. Labor gives, capital takes, and giving is the nobler function. Accordingly in any contest organized for gain alone, labor will never make way against capital. It has not, or has not enough of, the inspiring motive. Being positively moral in its nature, it can organize for justice, but if it outruns justice and begins pressing capital to death, it will rouse a sense of justice in capital itself, which will naturally think that it has a right to live, and, moreover, to get something, and a good deal, too, for its trouble; and when capital, with its ordinary inspirations thus reinforced, turns upon labor in self-defence

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as well as self-assertion, with its full powers of political and practical organization, the moral and artistic fighting qualities of labor will make but a very poor show. . . .

"Life, in its very highest form, is not going to be for any of us a rest in any realized ideal, but a perpetual pegging away and patching away at a very imperfect and continually wasting actuality, until that final and only rest comes, on which the tragic drawback is that we shall not be aware of it when it has arrived."

In this matter Mr. Wallace touches very keenly the lines of study which should be carried to greater extent than he seemed willing or able to carry them, but his article is, as my own statements are, only suggestive; and if this suggestiveness leads some one into a careful and comprehensive study of the psychology of the labor question, I shall feel that the moments I have devoted to it have been productive of some good. The labor question is with us, but it must be considered upon a broad and philosophical basis and not narrowly upon certain existing phases.

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PAPERS READ.

The Economic Law of Competition and of Monopoly. By Allen R. Foote.

Remarks on Capitalization and Publicity. By Martin A. Knapp.

The Necessity of Organization among Employers. By David M. Parry.

The Right of the Laborer to His Job. By Walter S. Logan.

Recent Aspects of the Immigration Problem. By Roland P. Falkner.

Bosnia: A Problem in Civil Administration. By Wm. E. Curtis.

The Sources and Margin of Error in Census Work. By Le Grand Powers.

Requisites in Crop Reporting. By H. Parker Willis.

Railway Bonuses in the United States and Canada. By James Edward LeRossignol.

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Some Views of Recent Sociology. By James H. Baker.

Growth of Great Cities. By E. L. Corthell.

The Pan-American Union and the Bureau of American Republics. By W. W. Rockhill.

Work of the Bureau of Insular Affairs. By Clarence R. Edwards.

The Consular Service and Foreign Trade. By Frederic Emory.

The Relation Between Exports and Imports. By T. E. Burton.

Tropical Development a Necessity of World Progress. By O. P. Austin.

Economic Operations of the Treasury Department. By Milton E. Ailes.

Effects of the Inflow of Gold. By Ellis H. Roberts.

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Inflation through the Expansion of Bank Deposits. By Joseph French Johnson.

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Is an Ideal Money Attainable? By Charles A. Conant.

Co-operation, Coercion and Competition. By Lindley M. Keasbey.

Economic Work of the Weather Bureau. By Willis L. Moore.

Economic Work of the Bureau of Animal Industry. By D. E. Salmon.

Economic Work of the Bureau of Plant Industry. By B. T. Galloway.

Economic Work of the Bureau of Chemistry. By H. W. Wiley.

Economic Work of the Bureau of Soils. By Milton Whitney.

Economic Work of the Office of Experiment Stations. By A. C. True.

Economic Work of the Division of Entomology. By L. O. Howard.

Economic Work of the Biological Survey. By C. Hart Merriam.

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The Economic Value of the Remaining Public Lands. By J. D. Whelpley.

Outlook of the Timber Supply of the United States. By B. E. Fernow.

Sociological Aspects of the Irrigation Problem. By Guy E. Mitchell.

An Inquiry into the Composition of Creamery Butter. By Henry E. Alvord.

Education for Farmers. By W. M. Hays.

School Gardens. By Miss Louise Klein Miller.

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SECTION K.

Physiology and Experimental Medicine.

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ADDRESS

BY

WILLIAM H. WELCH,

VICE-PRESIDENT AND CHAIRMAN OF SECTION K FOR 1902.

THE ORIGIN AND AIMS OF THE NEW SECTION OF PHYSIOLOGY AND EXPERIMENTAL MEDICINE.

As this is the first meeting of the newly established section of Physiology and Experimental Medicine of this Association it is appropriate to say something concerning its origin and purposes. Those who were most active in directing the recent efforts, which find their first full expression at its present session, to increase the usefulness of the American Association for the Advancement of Science by making it more broadly and authoritatively representative of science in America, naturally desired that the science of medicine should not be without some representation in this important and far-reaching scheme. It is not necessary on this occasion to urge the claims of medical science to such recognition or to do more than point to the history and achievements of the "Versammlung Deutscher Naturforscher und Aerzte" as an example of the mutual benefits to be derived from such association of medicine with other sciences. One point, however, may be emphasized in this connection. In this country and under our form of government the interests of science are peculiarly dependent upon public opinion, and it is therefore important that this opinion should be properly informed and directed. There are occasions when the voice of science should be forcibly uttered in a way calculated to influence governmental authorities and the general public. This Association, by its large membership, nationally representative character and wide

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scope is fitted to express in an impressive manner accepted scientific opinion, and it may be important for medicine, for science and for the public welfare that medical science should be represented in the Councils of the Association.

The determination of the precise way in which medicine should be brought into organic relation with the Association for the Advancement of Science is attended with certain obvious difficulties, and the existing solution of this problem is, I think, to be regarded only as partial and tentative. The plan of organization of the Association suggests, if it does not require, the formation of a permanent, separate section representative of medicine in some of its scientific aspects. There has therefore been added to the previously constituted sections a tenth one designated as the "Section of Physiology and Experimental Medicine," a title broad enough to include all but the purely clinical branches of medicine.

If this new section is to hold separate annual sessions with the Association for the reading of papers, the question at once arises whether there is any need for what will be practically a new national medical society, and whether it can secure the active support of those whom it is desirable to interest in its work. Many of us think that the limit of human endurance has about been reached in the way of formation of local and national societies devoted to medicine in its general or in its special aspects, and under such circumstances whoever adds to the existing burdens of this kind assumes a grave responsibility.

Another consideration is that the efforts to secure the meeting with the Association during convocation week of the various national societies devoted to the fundamental medical sciences have, at least on the present occasion, met with almost complete success. It has, therefore, been decided at present to regard the meetings of these societies as a substitute for special scientific sessions of this Section of the Association, and certainly no programme which could be arranged for the Section could rival in interest and value the combined programmes of the American Physiological Society, the Asso-

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ciation of American Anatomists, and the Society of American Bacteriologists, with which may be associated such kindred subjects as anthropology, psychology, microscopy and morphology, also represented by special societies. The only separate meeting of the Section at present designed is that for the address of the Chairman, with which I think it would be well to combine on this occasion some discussion by the members upon the future policy of this Section.

An essential part of the plan thus briefly outlined is that the Chairman of the Section, being by virtue of his office one of the Vice-Presidents of the Association, and the Secretary become members of the Council of the Association, and thus secure what is important and especially desired—the representation of medicine in the deliberations and action of the Council.

It is evident from what has been said that the organization of this Section has proceeded only so far as the path seemed clearly marked out, and that the opportunity is open for future developments along whatever lines may seem best to the members with the approval of the Council. It is possible that it may be deemed expedient to adhere for some time to the present rather limited plan of organization, but I should hope and expect that a seed has here been sown capable of richer fruitage than this plan now contemplated.

As regards our future policy, I may be permitted to make one or two suggestions. For the success of the Section it seems to me most desirable to secure so far as possible the interest and support of the existing national societies which represent the fundamental medical sciences, as anatomy, physiology, pathology, bacteriology, and hygiene. These societies of course will not, nor is it desirable that they should, relinquish their independence, but they will greatly aid this Section, and I think find it advantageous to themselves by continuing to meet as often as convenient during convocation week at the same place with the Association for the Advancement of Science.

A most important question seems to me to be whether after all the Section may not be made more useful by repre-

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senting some aspects of medical science not already provided for by existing societies. There has been a surprisingly large increase in the membership of the Association during the past year by the prompt response to circular letters sent to members of the medical profession calling attention to the establishment of the new medical section and inviting application for membership. A large proportion of these new medical members are practicing physicians who are not likely to become connected with any of the special affiliated societies. While they will doubtless find much to interest and instruct them in the proceedings of the Association and of its sections, and in the meetings of the various affiliated societies, as well as in the columns of the weekly journal "Science," they may, I think, reasonably expect to find under the shelter of the Section devoted especially to medical science something more nourishing than the annual address of the Chairman.

The idea has suggested itself to me that this Section might become a useful and influential body by representing the Science of Medicine in a broad, as distinguished from a narrowly specialistic sense, with particular emphasis upon the unity of medical knowledge, upon the correlation of the various special medical sciences and upon the relations of medicine to other sciences. Specialization has been undoubtedly the great instrument of modern scientific discovery, nor would I be understood to decry it, but it is attended with certain generally recognized dangers, and, as I have already indicated, there is no necessity of making further provision for societies devoted to the specialized medical sciences.

The medical section of this Association would seem to be the proper place for the realization of the conception which I have suggested, and upon the basis of this idea I believe that attractive programmes could be arranged. For example, under the auspices of this Section there might be occasionally joint meetings of certain sections and affiliated societies for the combined discussion of subjects of mutual interest to medical and other sciences, and communications of importance to medicine embodying the results of investigations in any field of science would be appropriate and welcome. Then advan-

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tage could be taken of opportunities here offered, which are not enjoyed by any other medical society in this country, of meeting with investigators in all the sciences of nature and of man. I need not here pause to specify the many points of contact between the science of medicine and other sciences. It would certainly be stimulating and profitable to hear at first hand and authoritatively from the physicist, the chemist, the engineer, the zoologist, the botanist, the anthropologist, the embryologist, the psychologist, the results of investigations which bear upon medicine, and on the other hand there are many medical researches of which the reports would interest workers in other sciences.

There are so many subjects which could be illuminated and furthered by their joint discussion by medical men and other scientists that I cite almost at random such examples as the participation of physicists in a consideration of the scientific and practical applications of the Roentgen rays, and Bequerel rays, of chemists in similar applications of physical chemistry to physiology and medicine, of zoologists in questions relating to animal parasites and the spread of certain infectious diseases by mosquitoes and other insects, of botanists in many problems relating to bacteria, of embryologists and biologists in many medical questions pertaining to fundamental properties of the cells, of psychologists in the consideration of nervous phenomena, normal and abnormal, of sociologists in discussing diseases of occupations and certain problems relating to preventive medicine, of engineers with reference to bacteriological and hygienic problems connected with the important subjects of water-supply and sewage-disposal. Doubtless other equally pertinent examples will occur to you, but I have said enough, I trust, to make clear my general ideas upon this subject. My purpose now is simply to point out for your consideration that there are fields, not already pre-empted by existing societies, which this Section with industry and wise management may cultivate with good prospect of a rich harvest.

I shall not in this address follow this topic further, as it seems to me better to leave to the deliberation of the officers

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and members of this Section and of the Council of the Association the detailed elaboration of this plan or of any other plan which may be suggested, if it should be deemed wise to extend the scope and work of the Section. Whatever scheme is adopted it should be sufficiently elastic to permit development along those lines which time and experience clearly indicate as the most advantageous.

[The remainder of Dr. Welch's address was extemporaneous, and he informs the Secretary that he has not been able since its delivery to write it out. It was devoted to a consideration of "the relation of medical science to other sciences."]

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PAPERS READ.

[No papers were read before Section K at the Washington Meeting, those submitted having been referred to the Medical Societies meeting in affiliation with the Association.]

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EXECUTIVE PROCEEDINGS.

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EXECUTIVE PROCEEDINGS.

REPORT OF THE GENERAL SECRETARY.

The fifty-second annual meeting of the Association, which was held in Washington, D. C., from December 29 to January 3, was noteworthy in many respects as marking the passage to a new order of things in the position and conduct of the Association. The total enrollment reached 989, which is second to that of the Boston meeting in 1880, when 997 were enrolled, and to that of the second Philadelphia meeting in 1884, when 1,261 enrollments appear. Of these, however, 303 members of the British Association represent complimentary enrollments. The geographic distribution of the members in attendance was as follows: District of Columbia, 354; New York, 133; Massachusetts, 82; Pennsylvania, 70; Ohio, 39; Maryland, 38; Illinois, 27; Connecticut, 23; Michigan, 22; New Jersey, 19; Wisconsin, 19; Indiana, 16; Virginia, 14; North Carolina, 13; California, 12; New Hampshire, 10; Missouri, 8; Canada, 8; Nebraska, 7; Minnesota, 7; Vermont, 6; Rhode Island, 4; Tennessee, 4; Kentucky, 4; Iowa, 4; Florida, 3; Maine, 2; West Virginia, 2; South Carolina, 2; Georgia, 2; Texas, 2; Montana, 2; Colorado, 2; Delaware, 1; Wyoming, 1; Arkansas, 1; Mississippi, 1; Kansas, 1; South Dakota, 1; Alabama, 1; New Mexico, 1.

Foreign attendance: Canada, 8; England, 1; Ceylon, 1; Nicaragua, 1.

In addition to these, 363 members of affiliated societies also registered at the office of the Association, so that the total enrollment of scientific men in attendance at the meetings was 1,352, and the total attendance may be conservatively estimated as not less than 1,500.

The membership of the Association, which had reached at the Pittsburgh meeting a total of 3,473, was augmented by the election at this meeting of 392 additional persons. One may assert

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with reasonable confidence that the gathering was the most representative and extensive which has ever been held under the auspices of any purely scientific association in this country and stands in favorable comparison with any similar congress in other lands. This was undoubtedly due in part to the advantages of Washington in accessibility and attractiveness, as well as to the large number of affiliated societies which co-operated in the gathering. One may well affirm that the experiment of changing the time of meeting has proved a distinct success, and this is evident not only in the size of the gathering but in the characteristic features of the series of meetings as well.

In the first place, it was noteworthy that the attendance was composed in great majority of the working scientific men of the country. The meetings of the various sections were well attended, and the spirit of the sections was one of work, most gratifying to those who look for renewed scientific interest and activity as a result of the change in policy of the Association. It is further noteworthy that the number of affiliated societies has been increased by the addition of many of the permanent scientific organizations of the country. Such an assemblage could not be made without numerous and even serious conflicts, together with the inconvenience and even friction which is attendant upon such relations. While this was noticeable in a few points which may possibly result in the temporary withdrawal of a few organizations, the advance made has been no less permanent than real in character.

To be sure, there are some scientific men who have not yet grasped the meaning of organization in scientific fields, and to whom the temporary inconveniences of an affiliation, the minor details of which have not yet been completed, appear to overshadow the great benefits which must result to science at large from the strength of the ultimate union. Despite this, the broader view has appealed so strongly to the members of most sections that amicable relations have been entered into between these and the national societies of technical character, and there has resulted a great improvement of the program for those in attendance upon the meetings and of effort and influence for the mutual advancement of the organizations. No one can doubt this on examination of the programs of the sections, which manifest an especially high standard in the character of the papers presented. Those in attendance upon future meetings may look with confidence to the presentation only of that which is most valuable to the worker in the field of the section. The marked improvement in the character of the contributions can only be demonstrated by the reports of the secretaries, which have been published in *Science*. The more serious character of the meeting was directly reflected in the marked respect paid to it by the press, and the period during

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which the influence of the Association will be commensurate with the importance of the subjects it represents may be confidently said to have commenced.

Despite occasional criticisms of individuals as to the excessive growth of machinery, the Association still needs perfecting in some details of organization in order to handle with expedition and without friction the enormous mass of business incident to an association of such wide scientific interests. Many details might profitably be systematized and removed from the hands of the overburdened secretaries, to be discharged in routine fashion by errand boys or clerks, and once provided for, would be carried out through successive years as a matter of course and without demand upon the time of any officer of the Association, whose energy may better be devoted to the performance of the scientific duties connected with his post. Every means possible should be employed to enable officers, as well as members, to lend their energies to those objects for which the Association primarily exists, and with the perfection of this machinery will cease of necessity the isolated criticisms which have been made by those of pessimistic habit with regard to the over-organization of the Association. The same machinery which was adequate to provide for the needs of an organization of 1,000 members with an annual attendance of 200 will not suffice for an association of four times that size and attendance. The sooner scientific men profit from the experience and practice of successful enterprises in the world of business, the greater will be the success of the forward movement in the world of science.

One cannot overestimate the part which is being played in this new movement by the affiliated societies, many of international renown, which have come into relations with the Association. Most of these are of technical character and are establishing with the sections desirable relations of an advisory and directive type. This they are well able to do by virtue of the professional character of their membership, and American science may confidently expect great results from the intimate relation in which such societies stand to many of the sections. It is to be sincerely regretted that in one or two cases the spirit of the movement has failed to reach other organizations, where some members have strongly opposed the cultivation of any relations whatever, and it may be given as more than an individual opinion that such men have failed to give thoughtful consideration to the real consequences of the armed neutrality which their position invokes. It may be said with frankness that even before such organizations some matters of the most trivial character are presented, while the section programs have to offer that which would be of broad and genuine interest to the members of the society. Both sides have much to gain, and neither has anything comparable or even considerable to lose by the proposed *entente cordiale*.

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It would be improper to pass the subject of these affiliated societies without reverting in a word to one of an entirely different character which has played an important part at Washington. The American Society of Naturalists has performed an invaluable service for those in attendance in its afternoon discussion on the most effective use of endowments for scientific research, which was participated in by six members of broad view and striking individuality, and by its annual dinner, with an address by the president on the characteristics and distribution in different fields of American men of science, which provoked generous and general discussion of the questions involved.

Important progress was made toward the establishment of a permanent policy in the Association by several amendments to the constitution and practices which were put into operation. The members of the sectional committees were elected for terms varying in length from one to five years, thus insuring the continuance of at least four members familiar with committee work from one year to the next; the secretaries of the sections were elected for terms of five years and the council elected nine fellows at large for varying terms. The continuity this secures in the governing body of the Association will add greatly to its efficiency in the advancement of science.

The following resolutions of importance to the policy of the Association were discussed and adopted:

Resolved, That any section is hereby authorized to arrange through its sectional committee for an independent summer meeting in any year when the Association fails to hold a summer meeting; provided, that the time and place of meeting and the general program be approved by the president and permanent secretary of the Association and that a full report of its meeting be sent to the permanent secretary. The expenses of any such meeting to an amount not exceeding fifty dollars will be borne by the Association.

Resolved, That Section E is hereby authorized to suspend its scientific program of the reading of papers at any winter meeting when the Geological Society of America meets in conjunction with the Association; provided that the Geological Society includes in its program the papers of worthy character offered by members of the section who are not Fellows of the society.

Resolved, That each section is recommended to hold during each general meeting at least one afternoon session when a program of general interest shall be presented.

It was recommended that the elections to fellowship be announced to the section from which the member elected had been recommended.

The council voted unanimously to increase the salary of the per-

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manent secretary from $1,250 to $1,500 on account of the greatly increased membership of the Association and attendance at the meetings, which have multiplied the duties devolving upon the office.

The amendment to the constitution proposed at the Pittsburgh meeting and printed in full in SCIENCE, Volume XVI, page 42, was adopted, and further amendments were presented altering the word "assessment" to "dues" in three places.

Resolutions demonstrating the important part that will hereafter be taken in the Association by the newly established Section of Physiology and Experimental Medicine, were passed as follows:

Resolved, That the American Association for the Advancement of Science hereby records its sense of the great loss sustained by science in the death of Major Walter Reed, surgeon in the United States Army, and its appreciation of the far-reaching and invaluable services which he has rendered to humanity. By solving the problem of the mode of spread of yellow fever, Major Reed not only made a great contribution to science, but at the same time conferred inestimable benefits upon his country and upon mankind. To have discovered and demonstrated the methods, which have already been successfully tested in Cuba, of eradicating a wide-spread and terrible pestilence, is a benefaction of imperishable renown, of incalculable value in the saving of human lives, of vast importance to commercial interests, and deserving of the highest rewards in the power of his countrymen to bestow. This Association earnestly urges upon the attention of Congress the duty of making full provision for the support of his family.

Resolved, That the President designate a committee of nine members of this Association, with power to increase its number, which shall be authorized and requested to devise and carry out a plan, or aid in similar efforts elsewhere instituted, by which a suitable and permanent memorial of this great benefactor of his race may be secured. This committee shall be authorized to prepare and publish a statement of the services of the late Major Reed in discovering the mode by which yellow fever may be exterminated.

The following members were appointed by President Remsen to serve as such committee: D. C. Gilman, A. Graham Bell, George M. Sternberg, Seth Low, Abram S. Hewitt, J. G. Schurman, S. E. Chaillé, W. H. Welch, Charles S. Minot.

The second resolution was as follows:

Inasmuch as the construction of the Isthmian Canal is through a region in which without energetic sanitary control there is sure to be enormous loss of human life from preventable diseases, particularly from pernicious malaria and yellow fever, as well as great waste of energy and of money from disabilities caused by such diseases; and

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Inasmuch as the measures for the restraint of these diseases, which have already achieved even their extermination in Cuba under American administration, require expert knowledge based upon practical familiarity with tropical diseases, experience in the application of these measures, and large authority in their administration;

Resolved, That the American Association for the Advancement of Science begs most respectfully and earnestly to call to the attention of the President of the United States the importance of appointing as a member of the Isthmian Canal Commission a medical man possessed of the qualifications indicated. The Association is convinced that the mere employment of such a sanitary expert by the commission will not be likely to secure the desired results.

Resolved, That the Permanent Secretary of the Association transmit a copy of these resolutions to the President of the United States.

Section F recommended to the council the following resolution, which was adopted:

The American Association for the Advancement of Science heartily endorses the plan of converting the Donnelson estate, which has recently become the property of the State of Indiana, into a State Reserve, and urges upon the legislature of Indiana the advisability of setting aside a part of it for an experimental farm for the investigation of cave animals and plants by American naturalists.

The grants recommended by the council and announced to the general session were as follows:

To the Committee on the Atomic Weight of Thorium, $50.

To the Committee on Anthropometry, $50.

To the Concilium Bibliographicum, $100.

The following reports of committees were submitted and adopted:

TWENTY-FIRST ANNUAL REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.

The Committee on Indexing Chemical Literature, appointed by your body at the Montreal meeting in 1882, respectfully presents to the Chemical Section its Twenty-first Annual Report, covering the twelve months ending June 1, 1903.

WORKS PUBLISHED.

An Index to the Literature of Thorium (1817-1902). By CAVALIER H. JOÜET, Ph. D. Smithsonian Miscellaneous Collections, No. 1374. Washington City, 1903.

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References to Capillarity to the end of the year 1900. By JOHN URI LLOYD (aided by) SIGMUND WALDBOTT. Bulletin No. 4 of the Lloyd Library of Botany, Pharmacy and Materia Medica. Cincinnati, Ohio, 1902. 212 pp. 8vo.

The 665 "references" extend from 1519 to 1900; each is accompanied by a summary of the contents of the paper cited.

The Journal of the American Chemical Society. General Index to the first twenty volumes, 1879–1898, and to the Proceedings, 1877–1879. Easton, Pa., 1902. 237 pp. 8vo.

Though issued anonymously the Preface bears the initials of E. W. Morley, and O. F. Tower, and the labor was one of love. Accuracy of detail and adequate treatment on every page are its admirable features. Besides an index of Authors and an index of Subjects there is an index of Obituaries which is suggestive. Also an index of new books.

NOTES ON FOREIGN BIBLIOGRAPHIES.

A Bibliography of Steel-works' Analysis by HARRY BREARLEY forms an Appendix to the volume entitled "The Analysis of Steel-Works Materials," by HARRY BREARLEY and FRED. IBBOTSON. London, 1902.

This Bibliography comprises 1858 references, which occupy more than 130 pages 8vo. The items are grouped under seven heads, besides minor subdivisions; the literature, is, however, very incomplete, being confined to four British Journals.

A Catalogue of the Library of the Chemical Society [of London]. Arranged according to Authors with a subject Index. London, 1903. 8vo. 324 pp.

International Catalogue of Scientific Literature. First Annual Issue [for the year 1901]. D. Chemistry. Published for the International Council by the Royal Society of London. London, 1902. Vol. II. Part I. June, 1902.

WORKS IN PROGRESS.

A second Supplement to the Select Bibliography of Chemistry, by Dr. H. Carrington Bolton, has been completed and accepted for publication by the Smithsonian Institution. It brings the literature down to the end of the year 1902.

An Index to the Literature of Cadmium has been begun byProf. Ernest N. Pattee, of Syracuse University.

An Index to the Literature of Glucinum has been begun by Prof. Chas. L. Parsons, of New Hampshire College, Durham, N. H.

An Index to the Literature of Germanium, Gallium, and Indium has been begun by Dr. Philip E. Browning, of New Haven, Conn.

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Mr. Frank R. Fraprie, writing from Munich, Bavaria, reports substantial progress on an Index to the Literature of Lithium, Cæsium, and Rubidium.

Mr. Benton Dales is engaged on an Index to the Literature of the Yttrium Group of the Rare Earths. His address is Ithaca, N. Y.

H. CARRINGTON BOLTON (in Europe),
F. W. CLARKE (in Europe),
ALBERT B. PRESCOTT,
ALFRED TUCKERMAN,
H. W. WILEY,

June 1st, 1903. *Committee.*

REPORT OF COMMITTEE ON ATOMIC WEIGHT OF THORIUM.

To the Council of the American Association for the Advancement of Science.

GENTLEMEN:

Our initial [report, presented at the Pittsburg meeting, consisted of a statement of the preparation of several kilograms of chemically pure thorium compounds to be used in the work. The Committee begs leave to report at present that Messrs. Chas. Baskerville and R. O. E. Davis in prosecuting the work, instituted a series of experiments looking to an improved method for halogen determination, that a simple compound, as thorium tetrachloride, containing but two elements, might be used in establishing the atomic weight of thorium. Their results are presented before Section C at this meeting.

With pure material prepared and a satisfactory method at hand, these gentlemen hope to present final results at the next meeting of the Association. The Committee therefore reports progress.

Respectfully submitted.

CHAS. BASKERVILLE, *Chairman*,
F. P. VENABLE,
JAS. LEWIS HOWE,
Committee on the Atomic Weight of Thorium.

REPORT OF THE COMMITTEE ON ANTHROPOMETRY.

This committee begs to report that anthropometric researches have been continued at Columbia University under the direction of its New York members and with the co-operation of Professor Farrand, Professor Thorndike, Dr. Wissler, Mr. Bair, Mr. Davis and Mr. Miner. Tests have been made on the freshmen entering the college, calculations have been carried out on measurements

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of school children, and new determinations of the mental traits of school children have been made and correlated. The chairman of the committee has carried forward an extensive anthropometric study of American men of science, the preliminary results of which formed the subject of his address as president of the American Society of Naturalists. An anthropometric laboratory has been arranged at the present meeting of the Association, with the $50 appropriated at the Pittsburgh meeting for the purpose, and tests of the physical and mental traits of members are being made. We ask that this committee be continued and that a further appropriation of $50 be made in order that a similar laboratory may be arranged at the next meeting of the Association.

J. McK. CATTELL,
W J McGEE,
FRANZ BOAS.

REPORT OF THE COMMITTEE ON THE STUDY OF BLIND VERTEBRATES.

Council, American Association for the Advancement of Science.

GENTLEMEN:

In behalf of the committee on cave investigation, I beg leave to submit the following report of work in hand and contemplated:

The most important single item of interest is the discovery that there are two instead of one species of *Typhlichthys* south of the Ohio river. I secured the second species at Horse Cave, Kentucky, in numbers and under conditions that practically insure the securing of a complete series of individuals illustrating the life history from the egg to old age.

A colony of *Amblyopsis* has been successfully transplanted to a cave within five miles of my laboratory, where they are breeding.

A preliminary examination of the eyes of the Cuban blind fish shows that the amount of ontogenetic degeneration is very great. and that the variability of this useless organ is all and much more than the cessation of natural selection would lead one to expect.

With an assistant I have undertaken a series of measurements of the physical conditions of Mammoth Cave, chiefly of the air currents at the entrance and in different galleries of the cave, and the temperature in a series of places.

The colony of *Amblyopsis* planted in an outdoor pool has come to grief. It demonstrated beyond a doubt that the cave vertebrates can be colonized in open pools, and this should be done at once.

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There is a balance of about $45 on hand out of the $75 appropriated at the last meeting.

Respectfully submitted.

C. H. EIGENMANN.

REPORT OF THE COMMITTEE ON THE QUANTITATIVE STUDY OF BIOLOGICAL VARIATION.

The most important events relating to the study of variation that have occurred during the past two years have been the establishment of the journal *Biometrika*, the foundation in America of a Society of Plant and Animal Breeding, the completion of the first volume of De Vries' "Mutationsteorie," and the rediscovery of Mendel's Law of Hybridity. Especially the latter two events have awakened a strong tendency toward the experimental study of evolution.

During the last four months the recorder has visited many of the experimental evolutionists of Europe. While the total work on this subject in Europe is of the greatest importance, it is carried on under conditions that greatly hamper the work and make it impossible to start experiments that require to be carried on for a long period of years. Everywhere the hope was expressed that in America a permanent station for experimental evolution would be founded, and it was believed that the Carnegie Institution would be the proper organization to initiate and maintain such a station.

CHAS. B. DAVENPORT,
Recorder.

Owing to the fact that the meeting began before the close of the fiscal year, the financial reports from the permanent secretary and the treasurer were presented informally, and the formal reports were postponed until the April meeting of the council.

In the sessions of the council and of the Association the usual order of procedure was followed. Events of more general interest in these as well as during the days of the meeting may be chronicled as follows:

The first general session of the Association was held on Monday, December 29, 1902, at 10 A. M., in St. Matthews Curch. It was called to order by the retiring President, Professor Asaph Hall, U. S. N., who introduced the President-elect, Dr. Ira Remsen.

Dr. REMSEN said: As you will be obliged to listen to me a little later for a few minutes, I will not take your time now, but proceed with the program as laid down by the committee of organization. I shall call first upon the Hon. Henry B. F. Macfarland, President

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of the Board of Commissioners of the District of Columbia, who will speak on behalf of the District of Columbia.

Mr. MACFARLAND: Before I say my formal and official word of welcome, allow me to say that the District government is not responsible for the Weather Bureau. That is purely and entirely a function of the United States Government. However, I may say for the benefit of the Weather Bureau that inasmuch as the population of the District of Columbia is made up of representatives of every section of the country, the weather is changed from day to day so as to suit all. If you have had unpleasant weather this morning—and I do not assume that you have had it—you may be sure that by to-morrow the weather will once more be all that you can desire. I also hope that you will understand that the temperature of this cold hall does not represent in any way the temperature of our welcome.

On behalf of the executive government of the national capital, I have great pleasure in heartily welcoming you. Great in numbers, great in honors, representing the highest types of scholarship and of citizenship, the most brilliant and profitable forms of research and the most intellectual phases of our industrial life, your Association has peculiar claims upon our hospitality. The American capital should be, and is, peculiarly hospitable to the representatives of American science. Coming from every quarter of the continent, representing every important scientific society and institution, you have a distinction which sets you apart in our estimation from all other gatherings of the year in this headquarters of conventions. All that is noble, altruistic, self-sacrificing in your labors, all the achievements which shine in the fame of your illustrious members, all the promise of future accomplishment and future beneficence implied in your advancement of science—all these rise before our eyes as we think of your name.

Doubtless there are, human nature being what it is, unworthy men of science, men who serve her from mercenary or ignoble motives. But we believe that the members of your Association cherish her highest ideals and follow them with patience and fidelity. Therefore we honor you as we cannot honor men of lower ideals or more selfish motives. Therefore we believe that you are in the highest sense humane. Therefore we believe that while you deal with material things, you yet minister to the spiritual life of the nation. Therefore we summon you with confidence to oppose, with all noble souls, that materialism which would engulf our civilization.

Many of you are at home here and need no formal welcome. All of you ought to feel at home. This is the capital of science as well as the capital of politics for this country. Ever since the Civil War made it certain that the national capital would

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not be removed from this place, over which the greatest armies of all time had contended, the national Government has been building up here new and important scientific institutions increasing in magnitude, influence, and accomplishment every year, and drawing here many of the best men of science. There are now, I suppose, more members of your Association resident in the District of Columbia than anywhere else, and nowhere else, I suppose, is more important work being done by men of science. The Smithsonian Institution, the Naval Observatory, the Coast and Geodetic Survey, the principal ante-bellum centers of scientific work in the city of Washington, have many companions now, and a regiment of men are employed in the scientific part of the Government. They maintain in large part the Cosmos Club and the scientific societies represented in its membership. And now appears on the horizon the Carnegie Institution, which bids fair to dazzle our eyes before it reaches its zenith with the magnitude of its conception and the richness of its facilities for scientific training. Already the Government museums, libraries and laboratories are, as you well know, richly worthy of your attention, and there is promise of steady enrichment both in public and private scientific undertaking.

But apart from what must interest you here most as American scientists, we have in the National Capital what must interest you as American citizens. This is the home of the national spirit, of the national flag, of the national Government, incomparable in the wealth of its associations and memories and as a center of power and promise. Here the Republic finds national expression and from here it confers national and international benefit in its world-round activities.

Dr. REMSEN: I have now the honor to call upon the representative of our national Government, the Hon. David J. Hill, Assistant Secretary of State.

Mr. HILL: Mr. President, and members of the Association: The Government of the United States, being a government of the people, offers no princely patronage, and its rewards are not alone for an aristocracy of learning. Resting directly upon the will of the people, it exists for the people and exercises no paternalism in the extension and the diffusion of knowledge. Other governments have employed knowledge as an instrument for rendering the population subservient to the State. Our Government, on the contrary, is itself only an expression of the popular intelligence. When the monarchs and princes of Europe founded universities, endowed colleges, when Richelieu established the French Academy, when Catherine II created an imitation of it in Russia, there was underlying all these movements a motive ulterior to the progress of knowledge. It was the maintenance

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and preservation of monarchy by the subvention of intelligence and scholarship. The American system has introduced in the progress of the world a new order of things. If, on the one hand, it has committed the advancement of science to the hands of the people, on the other it has made the knowledge of the people available for the development of the Government. The inevitable consequence of making the State the predominant influence in the extension of knowledge was to make science a creature of the State, but it is a far higher and nobler conception, a conception which is the child of our modern democratic movement, that the State should be the creation of science; and it is this conception which underlies our American idea and our American practice. Left free to move along its own lines of development, every form of human energy is permitted to grow according to its own inherent formula. In the United States there is and can be—and it is something to be thankful for—no such thing as official science. Patient investigation, verified experimentation, correct generalization, and lucid statement—these are the only steps by which scientific recognition can be attained. There is among us no supreme authority to intimidate and discourage. The initiative among us is with the people, and the progress of science in America is a witness of the people's interest in it. Imposed from above, science could not fail to be a burden, but pressing upward from the living fountains of popular interest, it becomes a source of inspiration. The best security the promotion of knowledge can have is the existence of a great, widespread, popular association, such as this, devoted to its advancement.

But now let us look for a moment at the influence of science under our system upon our national governmental development. I have said that we have no official science, and this is true. But it is true, though it is quite another thing, that we have scientific officials. The original conception of government was that it is only a negative function—namely, to prevent everybody from doing wrong to everybody else. But we are seeing, and science has opened our eyes to it, that government has a positive function—namely, the development of the resources of the nation as a whole for our common good and to promote the welfare of the people. We have seen that individual and local effort is powerless to accomplish this, and there has grown up here in Washington a group of have seen that individual and local effort is powerless to accomplish this, and there has grown up here in Washington a group of important scientific operations devoted to this branch of Government business. It is unnecessary for me to name those Departments of the Government which employ scientific experts and conduct scientific work under their direction. Another speaker, Dr. Walcott, is far more competent to do justice to that subject,

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and it may well be reserved for him. But two points are worthy of the serious attention of this Association.

One of these is that it is because the initiative in science is with the people that our governmental work has become of a real scientific character. It has been owing to the scientific demand, the demand of the scientific men scattered throughout the country, that our governmental work should rise to the level of their comprehension in its needs and in its standards, that we have now at Washington a group of scientific experts of the highest character doing the work of the Government in their special branches, and not mere bureaucrats holding their places by political influence. You will meet in Washington in the employ of the Government men of the highest standing in their respective branches of science, recognized and honored by their colleagues throughout the country and throughout the world, not as authorities because they are officials, but as those who have become officials because they were first recognized authorities.

The other thought that I wish to leave with you is the elevating effect upon the entire official staff of the Government exercised by the presence of acknowledged experts in its scientific branches. It has come to be generally accepted that no man should hold any public office unless he is specially qualified by his knowledge to discharge its duties with intelligence. We may easily insist too much upon mere academic standards, but specific qualifications may well be accepted as the final test in every department of Government. It is much to be regretted that traditional ideas linger on among the people long after the popular impression is out of date. Among the advantages of frequent visits to Washington is opportunity to observe the progress that has been made and is still making toward higher standards in the public service. Few careful observers fail to note the ability, the fidelity, and even the enthusiasm with which much of the public service is performed, and this is but a natural result of specific adaptation to the duties to be discharged. It is difficult to conceive a higher type of patriotism than that of the public servant, who, in his daily labors combines a passionate love of his special pursuit with the thought that he is using his knowledge in the service of his country. A few days' sojourn among your co-workers here in Washington will reveal to you the existence of many patriots of this type. It is but a single phase of that nobler life which interest in the advancement of science always inspires. It is largely due to the work and influence of this scientific body, scattered throughout the nation, that these opportunities are rendered secure, because they are believed in by the people.

I welcome you, members of the Association for the Advancement of Science, to our National Capital, which is so largely indebted for its intellectual life to the fact of your existence.

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Dr. REMSEN: I shall call next upon Dr. Charles D. Walcott, Director of the United States Geological Survey, who will speak in behalf of the Washington Academy of Sciences and other scientific societies of this city.

Dr WALCOTT: It is a great pleasure to welcome the Association and its affiliated societies on the part of the Washington Academy of Sciences and the scientific societies of Washington. The Association, as the popular representative of our eighty-five millions of people, is doubly welcome at the Nation's Capital, where the Government is doing a great work for scientific administration and research.

We have heard expressed the fear that the influence of scientific men in Government employ would be detrimental to the development of pure research, not only in connection with Government work, but in the universities and other organizations where more or less research work is carried on. I think this fear groundless. A large part of Government work consists in the application of scientific principles and methods to the needs of the body politic and of the people generally—in appropriating the results of research to the benefit of mankind, rather than in merely developing the ideals of scientific theorists, who would investigate only for science sake regardless of what may be of service to humanity. I would not convey the impression that original research of the highest type is wholly neglected in Government laboratories. On the contrary, a great amount of time and energy is expended in pure scientific research under well-trained, able men. As the result of a decade of administration, I have found that co-operation with universities and research organizations has been most helpful to the Government work in my charge, and men from all sections of the country declare that great benefit has accrued to the institutions which have co-operated with the Government.

The private and quasi-public institutions on the one hand, and the Government scientific organizations on the other, have, for the most part, independent fields. Research is a necessity in the training of men. It is generally recognized that the university must sustain original research in order to give its staff the opportunity to instruct the student in methods of research and thus prepare the more gifted men for future work of a high order, either in the university laboratory or elsewhere. The better qualified the teachers and the better their equipment for research the higher the rank of the university. The Government scientific organization, on the other hand, should make practical application of all scientific data available to the advancement of the welfare of the nation, independently of influence or prejudice. New problems appear at every advance, however, and if the university has not the data or opportunity for solving them, the Gov-

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ernment organization must conduct its own research, as far as it may be necessary, and thus the two classes of organizations meet on common ground. They are interdependent to a greater degree than most of us imagine. That which injures one injures the other, and that which sustains and broadens one sustains and broadens the other.

I speak of this to-day because never before has there been such a gathering of university and Government scientific men as assembles here this week. Such a gathering should be fruitful in the removal of misconceptions. It is my personal conviction that if every man engaged in scientific research in the country at large would acquaint himself with the men and methods of work prevailing in Washington, and if every scientific employee in the bureaus of the Government would visit the universities and become acquainted with the university men and their ideals, there would be a still greater tendency on the part of both to co-operate. This Association and other scientific organizations are doing a superb work in bringing together the scientific investigators of the country, thus providing for acquaintance and interchange of thought, which inevitably leads to co-operation and solidarity.

Again I welcome the Association in the name of the Washington Academy and the scientific societies of Washington, and of the laboratories and places which they may wish to visit in connection with the work which is going on in this city.

Dr. REMSEN: The Association is indebted to the Columbian University for its place of meeting, or rather, for the many places required for the many sections. Nearly all the meetings, if not all, are to be held in some of the rooms belonging to that institution. It is therefore peculiarly fitting that we should hear a word from the president of Columbian University, Dr. Charles W. Needham.

Dr. NEEDHAM: Mr. President and Members of the Association: It is a high privilege to speak for the educational institutions of Washington and extend their cordial welcome to this honorable Association and to the distinguished men who compose its membership. When it was known that your Association was to meet in this city the doors of every educational institution were opened and every facility that could contribute to your entertainment or the advancement of the purposes of your meeting was freely offered to you. It is fitting that these institutions should welcome the scientist. He discovers and gathers the facts and the laws which constitute in so large a part the knowledge which universities teach. It is science which gives us those facts, and a knowledge of those forces in nature and life which are the sure stepping-stones upon which man rises to higher and

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nobler living. The geologist's hammer opens the oldest and the most unprejudiced book of history; the furnace heat and the crucible reveal the riches and secrets of nature. The "Kingdom of God" has always been "at hand," but only to the diligent seeker is it found; the storehouse of nature is filled with all manner of precious gifts, but only to him who knocks is it opened, and she yields her secrets only to him who works while he waits. The world has found at last that while hope is a living force, work brings fruition. We are exchanging the "to-morrow" for the "to-day;" we are strengthening our faith by enlarging our vision; blind eyes will see and deaf ears will hear the truths that are near us and minister to our needs. Our fitness for better things increases with the knowledge and right use of the things we have. Knowledge of matter and the laws that govern it, of mind and of groups of men and the forces that control them, are the verities which the scientists are bringing us. Not only the individual man but the groups we call states, are looking to you to-day for the facts and truths upon which to build their prosperity and out of which in a large degree is to come their material wealth. A due appreciation of all branches of the mathematical, the physical, the natural and the social sciences is a special requirement of the present age. Upon a more enlightened employment of the products and the forces of nature will come those resources and riches which make a nation's wealth. A knowledge of sociological forces and social science only will make a perfect community possible. The propagation of an earnest and sound knowledge of all the sciences can alone advance the strength and power of a State in the great struggle of rival nations, and this knowledge must be comprehensive and full. Man cannot appropriate to his use the forces of nature and make all matter and mind his efficient agents without an intimate and accurate acquaintance with the physical, natural and social forces which move in all realms of activity with such tremendous and mysterious force and power. This knowledge can be obtained only by the free action of thought and an unrestrained activity in all investigation and in free discussion. The nations that suppress this activity and take no serious part in the general industrial movement, in the choice and preparation of natural substances, in the application of mechanics and chemistry, or in the understanding of social sciences will not find the road to prosperity and greatness, and must decay; while those that foster this knowledge will strengthen and develop in power and in the arts. We need not fear that this tendency to study nature and man for the sake of industrial progress, so universal in our day, will necessarily retard or dim the glory of the efforts of men in the domain of philosophy and classical history, or deprive life of the embellishments of the arts, or dim the vivifying glories of the imagination.

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So long as our institutions are free, the instruction intelligent and true, and there is everywhere an enthusiasm in the search after facts and law, we need have no cause to fear that any branch of knowledge will be neglected. All bring to the State the most precious fruits, whether they yield nourishment and wealth to man, or the permanent pleasures of the mind which are the glory and the richest heritage of the nation. As the discovery of steam and electricity have brought mankind into a common industrial life, so the revelations of science have brought a common wisdom and an almost universal desire for truth from every source. The university and the college will therefore ever greet the scientist as the revealer of truth.

Mr. President, I am profoundly impressed with the fact that this Association of men of science meets this morning, in response to a generous and cordial invitation, in an old and honored building, consecrated by a denomination whose glorious history stretches far back through centuries, bridging the middle ages, to the very dawn of the Christian era: a denomination which, through the triumphs and oppressions and crimes of military power, has brought down the splendid message that "the meek shall inherit the earth." Not the dominion of force nor the rule of the rich, but the gentle empire of mind and affection will be the final country of mankind.

Mr. President, in this building, once dedicated to affection, the educational institutions of this city give you men of science a cordial greeting.

Dr. REMSEN: I find that the next number, as they sometimes say, on the program is a reply by the President of the Association. I wish to say in this connection, gentlemen, that there are no less than twenty-four scientific societies in session at present, and that the American Association is one of these. To be sure, there is some connection between these numerous societies and the old association, but it is not an easy matter to state exactly what that connection is, and I shall not attempt it.

It is an interesting fact—one that is impressive, as has already been remarked—that this large body of scientific men and women should hold their first meeting in a building devoted to religion. I do not know whether this is a sign of the times, whether it is worth commenting upon, but it seems to me to be an interesting fact that science and religion should have come together in this way at this their first meeting in Washington. To be sure, I understand that the church is not used at present for religious purposes, and there may be some connection between the two facts.

The scientific men of this country are to-day and this week making an experiment of national significance. To those who have been in the habit of attending the meetings of the American

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Association, these meetings suggest summer excursions, rather hot weather, pleasant experiences in the open; they certainly do not suggest mid-winter. For the first time in its history, the Association, at all events, meets in the winter time and in what is known, perhaps not to all, but certainly to the scientific men and university men of the country, as "Convocation Week." It has been found that the scientific men, the university and college teachers of the country, were hard put to it to pass their time between Christmas and New Year's day. It hung heavily on their hands. They were distressed. And so some of our good brethren got together and voted that we must have something to do; and they appointed the week in which the first of January occurs as "Convocation Week," in which we are all to come together and work, stop this idling and get rid of this sad period of the holidays. As I understand it, it is impossible for us, in the future, to think of spending the holidays with our families unless we bring our families with us, and sometimes there are difficulties in the way of that. This is the experiment we are making, and this is the first evidence of the results of that experiment. How it is going to work no one is able to say at the present time. We hope, however, that the meetings will be larger than in the past and that they will be fully as helpful and pleasant as in the past; though some of the features we have always had in mind as pertaining to the meetings of the American Association will necessarily be lacking. The Association has met in Washington on two former occasions: first in the year 1854, nearly fifty years ago, next in the year 1891. This is the third meeting of the Association here.

I take pleasure on behalf of the Association and the other assembled societies in extending the thanks of those who have come together here to the representatives of the various organizations in Washington for what they have evidently done for our pleasure and for our comfort. I thank you, sir, as a member of the National Government; you, sir, as the representative of the District of Columbia; and you who represent the scientific societies of Washington, and Columbian University and the educational institutions, all have our hearty thanks. I extend thanks thus before the meeting takes place because what we have already seen is a sure indication of what is to follow, and I am certain that this will be the most successful meeting that the American Association for the Advancement of Science has ever held, and probably the most successful meeting the other scientific gatherings have held in any part of the country.

After the reading of reports by the General and Local Secretaries, and agreement upon the time and place of meetings, the session adjourned.

At 1 o'clock P. M., on Monday, the local committee invited

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visiting scientific people to a luncheon at the Arlington, and on the same afternoon the addresses of the vice-presidents were given as follows:

At 2.30 P. M.:

Vice-President Hough before the Section of Mathematics and Astronomy. Subject: "On the Physical Constitution of the Planet Jupiter."

Vice-President Franklin before the Section of Physics. Subject: "Popular Science."

Vice-President Weber before the Section of Chemistry. Subject: "Incomplete Observations."

Vice-President Culin before the Section of Anthropology. Subject: "America the Cradle of Asia."

Vice-President Welch before the Section of Physiology and Experimental Medicine. Subject: "The Origin and Aims of the New Section of Physiology and Experimental Medicine."

At 4 P. M.:

Vice-President Flather before the Section of Mechanical Science and Engineering. Subject: "Modern Tendencies in the Utilization of Power."

Vice-President Nutting before the Section of Zoology. Subject: "The Perplexities of a Systematist."

Vice-President Campbell before the Section of Botany. Subject: "The Origin of Terrestrial Plants."

Vice-President Wright before the Section of Social and Economic Science. Subject: "The Psychology of the Labor Question."

At this hour also was delivered the address of the president of the Astronomical and Astrophysical Society of America, Prof. Simon Newcomb.

The annual address of the retiring president, Professor Asaph Hall, U. S. N., entitled "The Science of Astronomy," was read on Monday evening. At its close Past President C. S. Minot spoke of the new movement on which the Association has entered.

On Tuesday evening the address of the president of the American Chemical Society, Dr. Ira Remsen, was given, and followed by the annual dinner of the society.

At the same time, Dr. C. Hart Merriam delivered the public lecture of the American Society of Naturalists on "Protective and Directive Coloration of Animals with Especial Reference to Birds and Mammals," which was followed by the smoker of the American Society of Naturalists and its affiliated societies. At the same time the Botanical Society of Washington received visiting botanists. The Sigma Xi Scientific Society also met the same evening.

On Wednesday afternoon at 3 o'clock the annual discussion of the American Society of Naturalists was held. The subject was

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"How can Endowments be used most Effectively for Scientific Research?" and the speakers were Professors T. C. Chamberlin, William H. Welch, Franz Boas, William M. Wheeler, Conway Macmillan and Hugo Münsterberg.

On Wednesday afternoon at 4 o'clock a public lecture was given under the auspices of the A. A. A. S. and the National Geographic Society on "Volcanoes of the West Indies," by Prof. I. C. Russell.

Mrs. Chas. D. Walcott gave a tea on Wednesday afternoon at 5 o'clock to visiting ladies of the Association and to the members of the Geological Society of America.

On Wednesday evening the annual dinner of the American Society of Naturalists was held, and the dinner was followed by the address of the president, Professor J. McK. Cattell.

The annual dinner of the Geological Society of America and a smoker tendered by the Chemical Society of Washington were also held.

On Thursday evening, through the courtesy of the board of regents and the secretary of the Smithsonian Institution, the U. S. National Museum was open from 8.30 to 11 P. M., to afford a convenient opportunity for viewing the collections.

On Friday afternoon at 4 o'clock an illustrated public lecture, complimentary to the citizens of Washington, was given at the Lafayette Opera House, by Professor John Hays Hammond. on "King Solomon's Mines, or the Mines of Ophir."

On Friday evening the trustees of the Corcoran Art Gallery and the local committee tendered a reception to the visiting members of the Association and the affiliated societies at the Corcoran Art Gallery, from 8.30 to 11 o'clock. On Friday evening also was held the dinner of the American Alpine Club.

On Saturday morning at 10 o'clock the President of the United States received the members of the A. A. A. S. and affiliated societies at the White House.

Resolutions of thanks for courtesies extended were offered by ex-President Minot and unanimously adopted at the closing general session. The institutions and individuals to whom the Association was especially indebted include: Columbian University, Cosmos Club, Local Committee, St. Matthews Church, Georgetown University, Carroll Institute, Press of Washington, Trustees of Corcoran Art Gallery, the President of the United States, Secretary of the Smithsonian Institution, Acting Director of the U. S. National Museum, Director of the Naval Observatory, Commissioner of Fish and Fisheries.

At the meeting of the general committee on Thursday evening it was decided to hold the next meeting of the Association in St. Louis during convocation week, 1903–'4, and to recommend Phila-

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delphia as the place of the following meeting. The following were elected officers for the St. Louis meeting:

President—Carroll D. Wright, Washington.

Vice-Presidents—Section A, Mathematics and Astronomy, O. H. Tittmann, Washington; B, Physics, E. H. Hall, Harvard University; C. Chemistry, W. D. Bancroft, Cornell University; D, Mechanical Science and Engineering, C. M. Woodward, Washington University; E, Geology and Geography, I. C. Russell, University of Michigan; F, Zoology, E. L. Mark, Harvard University; G, Botany, T. H. Macbride, University of Iowa; H, Anthropology, M. H. Saville, American Museum of Natural History; I, Social and Economic Science, S. E. Baldwin, New Haven; K, Physiology and Experimental Medicine, H. P. Bowditch, Harvard University.

Permanent Secretary—L. O. Howard, Cosmos Club, Washington.

General Secretary—Chas. W. Stiles.

Secretary of the Council—Chas. S. Howe, Case School.

Secretaries of the Sections—Section A, Mathematics and Astronomy, L. G. Weld, University of Iowa; B, Physics, D. C. Miller, Case School; C, Chemistry, C. L. Parsons, Durham, N. H.; D, Mechanical Science and Engineering, Wm. T. Magruder, Ohio State University; E, Geology, G. B. Shattuck, Johns Hopkins University; F, Zoology, C. Judson Herrick, Denison University, G, Botany, F. E. Lloyd, Teachers College, Columbia University; H, Anthropology, George H. Pepper, American Museum Natural History; I, Social and Economic Science, J. F. Crowell, U. S. Treasury Department; K, Physiology and Experimental Medicine, F. S. Lee, Columbia University.

Treasurer—R. S. Woodward, Columbia University, New York, N. Y.

HENRY B. WARD,
General Secretary.

REPORT OF THE TREASURER.

In compliance with Article 15 of the Constitution, and by direction of the Council, I have the honor to submit the following report, showing receipts, disbursements, and disposition of funds of the Association for the year ending December 31, 1902.

Receipts have come into the keeping of the Treasurer from three sources, namely: First, from excess of receipts over expenditures of the Permanent Secretary; secondly, from commutations of annual dues of life members of the Association; and, thirdly, from interest on funds deposited in savings banks and with the U. S. Trust Company. The aggregate of these receipts is $3,160.67.

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Disbursements made in accordance with the direction of the Council amount to $300.00.

The total amount of funds of the Association deposited in banks and with the U. S. Trust Company, and subject to the order of the Treasurer, December 31, 1902, is $14,987.74.

The details of receipts, disbursements, and disposition of funds are shown in the following itemized statement.

Dated April 1st, 1903.

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THE TREASURER IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

1902.	Dr.	
	To balance from last account	$12,127.07
June 28.	To amount transferred from funds of Permanent Secretary	2,000.00
June 28.	To 7 life membership commutations	350.00
Dec. 18.	To 5 life membership commutations	250.00
Dec. 29.	To 3 life membership commutations	150.00
Dec. 31.	To amount of interest received on funds deposited in Savings Banks and with U. S. Trust Co. as follows:	
	From Cambridge Savings Bank, Cambridge, Mass. $38.27	
	From Emigrant Industrial Savings Bank, New York, N. Y. 101.77	
	From Institution for Savings of Merchants' Clerks, New York, N. Y. 100.39	
	From Metropolitan Savings Bank, New York, N. Y. 102.37	
	From the U. S. Trust Company, New York, N. Y. 67.87	
		410.67
	Total	$15,287.74

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THE TREASURER IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

1902.	Cr.		
Jan. 21.	By grant (of 1900) paid C. H. Eigenmann of committee on study of blind vertebrates..		$50.00
June 23.	By grant (of 1901) paid J. McK. Cattell of committee on anthropometric investigations.....		50.00
July 14.	By grant (of 1902) paid D. T. MacDougal of committee on study of relations of plants to climate.....		75.00
Nov. 24.	By grant (of 1902) paid Chas. Baskerville of committee on atomic weight of thorium..		50.00
Dec. 12.	By grant (of 1902) paid C. H. Eigenmann of committee on study of cave fauna.....		75.00
Dec. 31.	By cash on deposit as follows:		
	In Cambridge Savings Bank, Cambridge, Mass.....	$1,122.59	
	In Emigrant Industrial Savings Bank, New York, N. Y.....	2,984.70	
	In Institution for Savings of Merchants' Clerks, New York, N. Y.....	2,868.86	
	In Metropolitan Savings Bank, New York, N. Y.....	2,901.52	
	In U. S. Trust Company, New York, N. Y.....	4,567.87	
	In the Fifth Avenue Bank, New York, N. Y.....	542.20	
			14,987.74
	Total.....		$15,287.74

I have examined the foregoing account and certify that it is correctly cast and properly vouched.

EMORY MCCLINTOCK,
Auditor.

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Report of the Permanent Secretary.

The matters heretofore referred to in the report of the Permanent Secretary, in so far as they relate to the annual meeting, have been covered in the report of the executive proceedings prepared by the General Secretary, and duplication is avoided by omitting them under the present head.

The following is a comparative statement of the roll of members as printed in the Denver and Pittsburg volumes and in the present volume:

	Denver.	*Pittsburg.*	*Washington.*
Surviving founders	3	3	3
Living patrons	2	2	2
Living honorary fellows	2	3	3
Fellows	1,054	1,074	1,197
Members	1,904	2,392	2,787
Totals	2,965	3,474	3,992
Honorary life fellows (founders) included in the above	3	3	3

It will be noted from this statement that the year 1902 was a very successful one in actual growth of the Association. That this means a better financial condition is indicated in the financial report which follows.

L. O. Howard,
Permanent Secretary.

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L. O. HOWARD, PERMANENT SECRETARY, IN TION FOR THE ADVANCE-

From January 1, 1902, to

DR.

To balance from last account		$12,285.83
Admission fees	$4,454.00	
Annual dues for 1902	4,681.00	
Annual dues for 1903	7,724.00	
Annual dues for previous years	615.00	
Associate fees	132.00	
Fellowship fees	146.00	
Life membership fees	800.00	
		18,552.00
Publications	181.21	
Subscription for volume	1.50	
Binding	23.00	
Miscellaneous receipts	172.57	
Interest	57.29	
		435.57
		$31,273.40

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ACCOUNT WITH THE AMERICAN ASSOCIAMENT OF SCIENCE.

December 31, 1902.

Cr.

By publications.		
To publishers SCIENCE	$6,481.84	
Denver volume	1,135.53	
Pittsburg pamphlet	286.40	
On account Pittsburg volume	96.20	
		$7,999.97
By expenses Pittsburg meeting.		
Sectional secretaries' accounts and commutations	403.68	
General expenses	111.20	
		514.88
By expenses in propagandist work.		
Local committees' expenses	180.73	
Printing	300.35	
Postage	493.12	
Extra clerical help	233.88	
		1,208.08
By general office expenses.		
Express	369.07	
Postage	310.08	
Office supplies	9.97	
Telegrams	8.88	
Printing	122.35	
		820.35
By salaries.		
Permanent Secretary	1,250.00	
Assistant Secretary	500.00	
Assistant Secretary	250.00	
		2,000.00
By miscellaneous disbursements.		
Back volumes of proceedings	18.56	
Overpaid dues returned and cheques protested	35.95	
Advance to Washington local committee	125.00	
Bills from Secretaries Washington meeting	43.80	
Cash paid Treasurer	2,750.00	
		2,973.31
By balance to new account		15,756.81
		$31,273.40

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I hereby certify that I have examined this account and that it is correctly cast and properly vouched for, and that the balance was on deposit in Washington as follows: Citizens' National Bank (January 6, 1903), $12,699.31; National Safe Deposit and Trust Co. (January 1, 1903), $1,532.28, and American Security and Trust Co. (January 14, 1903), $1,525.22; in all $15,756.81.

G. K. GILBERT, *Auditor.*

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